THE

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THE

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WHAT WILL MARYLEBONE DO NEXT?

IF "all the world's a stage and all the men and women merely players," what part did the 3,000 Marylebone ratepayers play at their statutory meeting on Tuesday! Our readers who have followed this ridiculous matter from the commencement, and are acquainted with the story of municipal muddlement, will have no difficulty in furnishing a two-word answer. The Borough Council called its electors together to approve its Bill to permit of the payment of moneys due to the Metropolitan E.S. Co. in consequence of the award which had been made. What else *could* the Council do? As the Mayor of Marylebone—who, according to the *Times*, "managed by his patient good humour to get a hearing" where plenty of others were howled down—said: "The award had been made, and the money *must be found*." Yet this meeting of Marylebone's three-thousand, held in the Queen's Hall, Langham Place, refused to listen calmly to temperate speech in which the meeting was counselled to adopt the decision of the majority of its Council; indeed, it went so far as to decline by an overwhelming majority to approve the Bill. We cannot believe that this can be considered to represent the real feeling of the inhabitants of the borough—the threatened effect upon the rates notwithstanding. But even if it does, the borough cannot shuffle out of the matter in any way whatsoever, for it is hardly to be supposed that Parliament will stultify itself by interfering.

That Marylebone ratepayers are heartily sick of the electrical quandary into which successive Councils have placed them is clear, but they appear to overlook the fact that, apart altogether from the mere approval which they were called upon to give in statutory meeting, they are under moral obligation to stand by the action of those whom they elected to manage the public affairs of the borough. They must abide by the bargain which has been made for them, and soothe their ruffled spirits with the thought that their Council's ambitions in the direction of municipal trading have led them into their present undesirable position.

It may occur to some that it is little short of idiotcy to take a poll, after expensive arbitration proceedings, costing many thousands of pounds, have been held to decide the price at which the undertaking shall be acquired by the electors. Public opinion might have been taken at an earlier stage before ever arbitration proceedings commenced.

For years and years this matter has been before the borough, and the company from the first showed that, while open to negotiate with the Council, it intended to preserve a stiff back in the matter of terms, and to hold out for its just rights, until it came to the question of arbitration, and there it was content to leave the matter, for the impartial mind of a disinterested tribunal to give its final estimate of what was a fair and proper compensation for what the company was required to give up. Who dreamt that, after the award was taken up, one of the parties to the arbitration was going to refuse to fulfil its part of the bargain?

Are we to allow to municipalities privileges that private companies dare not claim? What would have been the position of a company had it failed to carry out its obligations as the Marylebone Council has done?

Over the Garden Wall.

Certain events of the past few days are calculated to arouse the thinking capacities of tramway engineers throughout the British Isles—if they are not too busily engaged in other directions, as appearances would suggest.

Electric traction on tramways is at the present time of fairly universal application, and it might be reasonably assumed that for several years past engineers have been fully conversant with the dynamical developments which have necessarily followed the great advance in weights and speeds associated with modern tramway conditions. Yet, is it not a fact that, with all our knowledge and appliances, we are unable to control a 10-ton car on an average gradient? Is it not equally true that we have not fully appreciated the problem of running a car round a curve at a speed slightly above the normal?

The two factors concerned are the track and the brakes. As far as the former is concerned, one is led to the assumption that the dimensions of the flanges and rail grooves have not increased in the same ratio as the tendency of the modern car to follow its natural inclination. How little change has taken place may be ascertained by making a comparison of the old Birkenhead horse-car track—the first in England, we believe—which is still down, with the Corporation's modern electrical track. Super-elevation of the outer rail, although quite possible on railways, is, owing to the necessity of following the contour of the road surface, generally out of the question in tramway work. Guard rails are not generally adopted, and rarely in the places where they are most needed.

Then, with the heavy wear which takes place on a curve, and which is intensified if that curve happens to be at the bottom of an incline, it is quite reasonable to suppose that, despite efficient first construction, such places soon attain, if anything, a worse condition than existed on the old horse tramway tracks, and it is hardly surprising, under those circumstances, that, with a heavy car running in excess of the normal speed, accidents occur at such places.

The tramway man will naturally respond by blaming the excessive speed, but, unfortunately, he must, when all is considered, come to the conclusion that speed is a matter largely out of his control. Is it not a fact that, with all our brakes, we are unable to control a car with certainty? We think that the recent accidents are abundant evidence of the point, and the Margate accident last year is an additional case. It would appear that any emergency brake, such as is usually provided for use on gradients, which does not reduce to an absolute minimum the factor of human judgment, is foredoomed to failure, and the utility of practically all brakes is, through this cause, limited. The Dewsbury tramway accident of last Saturday is an excellent illustration of the chances which the top-deck passenger, under present conditions, stands of arriving on the other side of somebody's garden wall—and it clearly proves that the brakes, *plus the man*, were not equal to the emergency.

A Gas Contemporary and the Chicago Fire.

The *Gas World*—with journalistic courtesy—has declined to accept the statistics given by us in our leading article on the Chicago fire, because we did not quote in full the names of the compilers and publishers of the book from which we quoted. That being so, we hasten to give our contemporary the information which presumably it is unable to procure for itself. The book in question is "Fires and Public Entertainments," by Edwin O. Sachs, and it was published between six and seven years ago by Messrs. Charles and Edwin Layton. It is a study of some 1,100 notable fires at theatres and similar buildings, and is primarily a statistical record whose figures have been analysed. The causes of fire are very difficult to ascertain, but of the 193 fires commencing at the *back of the house*, of which particulars have been obtained, 44 were due to defects in the gas installation, and 37 from open lights, such open lights being chiefly used in connection with gas illumination. The defects on record from electrical installations are seven, but, of course, the statistics extend over a considerable period when electric lighting did not exist. Next to gas and open lights come defects in the heating apparatus as a cause, of which there are 32.

We do not think that any electrical engineer has the least fear of gas competition when the relative safety to the consumer of the two illuminating systems is the point at issue.

Electricity in Coal Mines.

Electrically driven coal-cutting machines are coming largely into use in Lancashire. They have been extensively employed since 1899 by one of the most prosperous colliery concerns in that county, the Hulton Colliery Co., Ltd., whose mines are in the Wigan district, and they have been found to effectually supersede manual labour. The experimental stage has been passed. "It may be thought," said Mr. Alfred Tonge, who is intimately connected with the management, recently, "that we have carried experimentation too far, but I do not find that we have suffered much from this. Each make of cutter we have tried has some special feature which suits the mine. The Jeffrey disc long-wall cutter was our first choice, because it seemed best to us, at the time, for thin seams. It was put to work in a half-yard seam, and afterwards transferred to a 1 ft. 8 in. seam, and its work was so satisfactory that a second machine of the same type was purchased. The next kind of machine tried was the Diamond long-wall, which was used in a thicker seam, and after that the Morgan-Gardner, which latter was obtained chiefly for the purpose of enabling us to dispense with the use of rails in thin seams, and because of its compactness. Then we experimented with the Hurd three-face bar cutter and the Diamond three-face disc cutter, in our newly-opened pits." The general results of these experiments, Mr. Tonge said, was very satisfactory. The Jeffrey, the Diamond, and the Morgan-Gardner have been in use now four years, and have proved their superiority to manual labour in many ways. "The amount of coal cut by these machines," says Mr. Tonge, "in 1902, was 41,850 tons, or more than half the total amount cut by machinery in that year in the whole of the Manchester district, according to the report of H.M. Inspector of Mines. At the present time they are cutting at the rate of 100,000 tons for the year." He points out the specific advantages of the cutters. The economy really lies in the item of "filling and drawing;" and, in his opinion, the collier, as such, must really cease to exist if coal cutting is to find its true level. The higher wages in coal mining, as in other trades, will eventually be paid to the most intelligent workman, and not simply because a man works on the coal-face, as distinct from the roadways. Not the least important factor in the use of these mechanical cutters is a change in the character of the coal. There is less slack produced in proportion to "round coal." In the Hulton Collieries the production of coal has been increased about 10 per cent., and the size and quality has been, at the same time, improved.

Mr. Tonge claims for the electrical coal cutters the following distinct advantages:—(1) More output per man employed; (2) coal economically worked which previously had been unworkable at a profit by hand; (3) more systematic working; (4) better round coal in three out of four mines; (5) greater area exposed in the same time, in two out of four seams; and (6) premium per ton for risk of life reduced by one-third. These mechanical contrivances the collier looks upon as interlopers in his preserve. But work of a higher class is now displacing 33 per cent. of the collier's work, and that the most laborious. "Having installed the coal cutters at the Hulton Collieries," says Mr. Tonge, "the company consider a return to hand labour would be a step back into older and darker times."

THE DESIGN OF DIRECT-CURRENT MACHINERY.

By VAL. A. FYNN.

(*Concluded from page* 84.)

In the following, we will talk of a coil as being that number of turns which is arrived at by dividing the total number of turns on the armature by the number of commutator segments, except in the case of interpolated commutator sections, when a coil is to mean the total turns divided by the number of slots, since interpolation merely increases the number of commutator segments without reducing the turns in series of a coil as short circuited by the brushes.

An ordinary two-circuit single winding using only two sets of brushes will always short circuit under one brush ($p \times$ coils), where p stands for the number of pole-pairs of the machine, and these coils will be short circuited in *series* with each other.

The multiple windings never short circuit more than one coil in series under one brush.

Where in a two-circuit winding as many brush sets are used as there are poles, then somewhat unstable conditions prevail, as shown by the example in fig. 25, representing a four-pole two-circuit single winding.

All the brushes are supposed to be equal in width to two commutator segments, and equally pitched. Brushes of equal polarity are interconnected. Apart from the small number of slots and segments chosen, which does not influence these considerations, the conditions are normal. The heavily-lined and heavily-dotted coils are for the time being short circuited.

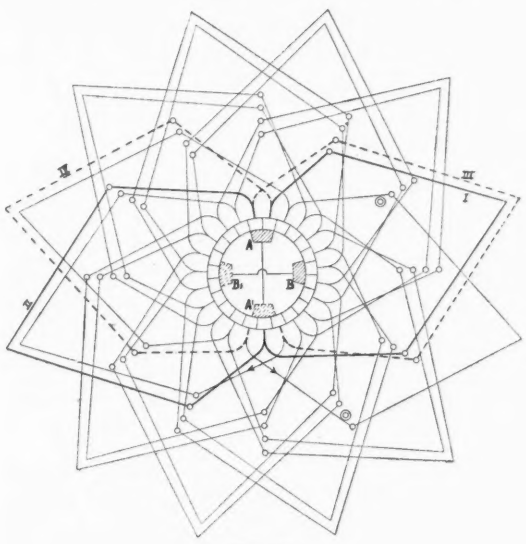


Fig. 25.

If the brushes A_1 and B_1 were added with a view to reducing the number of coils in series undergoing commutation, it is at the least doubtful whether the object will be achieved. Supposing the contact of A and A_1 with the commutator to be equally good, the tendency of the short-circuit current would still be to flow through coils I. and II. in series, and close through brush A, thus avoiding the resistance R of the connection between equal polarity brushes. For this path, the main resistance of which consists in the contact resistance from commutator segment to brush A, and back again to the adjacent segment, the E.M.F. of the coils I. and II. in series is available, whereas for the alternative path from A_1 through R to A, in addition to the two contact resistances between brushes and commutator segments, which can be taken as equal to the contact resistance in the alternative case, there is the resistance R, and only half the previous voltage to overcome it.

Coils III. and IV. are somewhat less liable to complete their short circuit under brush A, but nevertheless they have that tendency.

We have assumed that the contact resistance between brushes and commutator remains constant, but this condition is hardly to be expected in practice, particularly with carbon brushes, and the process is therefore uncertain.

It is also interesting to note that the two "volt-generating circuits" through this armature, indicated by small arrows in the fig. 25, both start in the position shown from brush A_1, which at that moment will carry the full line current. When the commutator has moved forward a little, brush A will take over that duty, and so on.

It appears certain from this that copper gauze brushes will give more steady results with this winding than carbons, but will not prevent the surging of the main current, although they will reduce this by unequal pitching at the expense of other complications. The connections between brushes of equal polarity must evidently present the least possible resistance.

But this diagram, fig. 25, also gives us an example of using practically twice as many segments as slots whilst halving the turns per coil. We say "practically twice," because, as a matter of fact, the number of segments is one short of that number, and this, together with the dummy coil it entails, the position of which is marked by two concentric circles, introduces an irregularity which militates against the use of this scheme in a closely-designed machine.

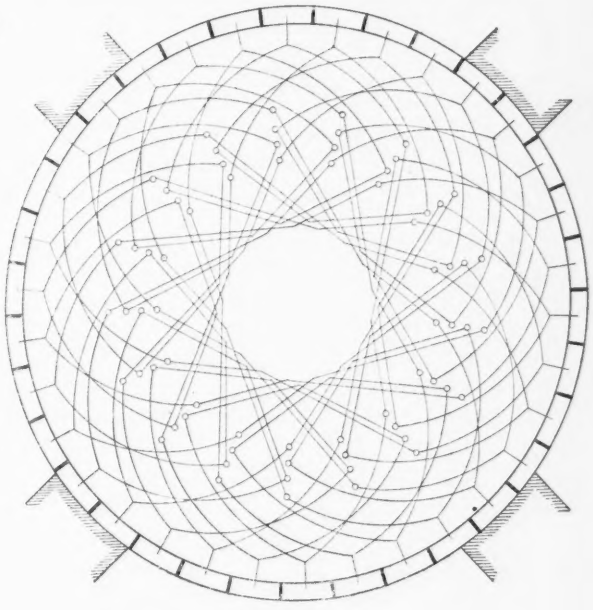


Fig. 26.

The stepping can be seen from the diagram, the coils being taken as consisting of one turn only.

The only winding which actually doubles the number of commutator segments whilst having the same number of turns per coil, and does not introduce any irregularities, is that shown in fig. 26, and discovered by the writer. In the patent specification No. 8,227 of 1900 relating thereto, this is described as evolved from the ordinary two-circuit winding. Examining the complete diagram from its own commutator end, it may also be described as a combination of multiple and two-circuit steps.

On the assumption that the winding is evolved from the ordinary two-circuit, its stepping may be expressed as follows in general terms :—

If (n) stands for the number of turns per spool, there being in the original winding as many spools as slots, and if (a) stands for the ratio of commutator segments to armature slots, then a commutator segment is to be connected to a part of the original spool at a distance of $\frac{(n)}{(2a)}$ turns from its beginning, and the next commutator segment is to be connected to a point of that same spool $\frac{n}{a}$ turns further on

until a point is reached, which is $\frac{n}{2a}$ turns from the end of that original spool.

The beginnings and ends of the original spools are to be inter-connected in the usual way, but not taken to any commutator segments.

When this winding is applied in practice it is, of course, wound from its own commutator end, and all solder joints other than those at that commutator are avoided, the whole winding process resolving itself into suitable alternation between a multiple and a two-circuit step.

Some care must be exercised as to the choice of the two-circuit step, so as to reach the various commutator segments in the proper sequence. Generally speaking, if the number of slots is $(p\,n + 1)$ where p is the number of poles, and n an integer, these steps will be symmetrical, whereas if the number of slots is $(p\,n - 1)$ they will be unsymmetrical.

As many sets of brushes are used with this winding as there are poles, and the results obtained are very excellent ones.

In all cases where more commutator segments are used than there are slots, the armature coils must be so disposed that to the advance of each segment corresponds an equal advance of the coil belonging to it.

We have seen what possibilities these various windings offer in the way of varying both the duration of the short circuit and the number of turns in series which can be shorted; a further very important item affecting the commutation is the magnetic reluctance of the path around the short-circuited conductors. Many years ago the author proposed a solution embodied in fig. 27, which has been very extensively and successfully used ever since.

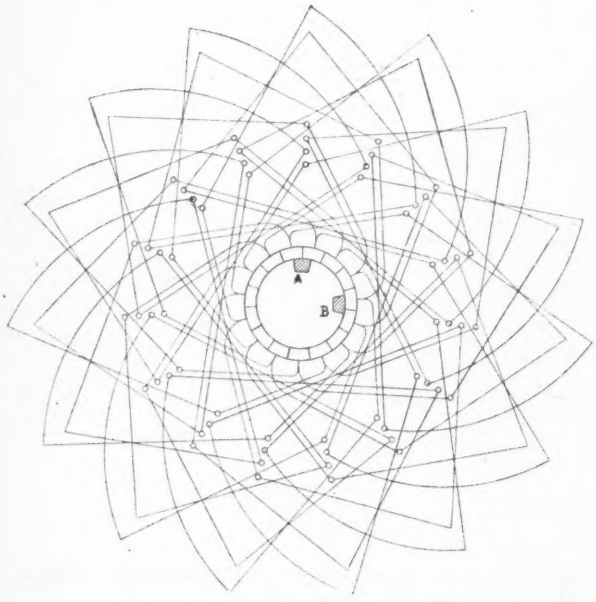


Fig. 27.

In order to reap the full benefit of this winding it is necessary to design the machine so closely that it would be bad without it. In other words, when properly applied, it allows one to design very closely indeed, without any risk from sparking.

In conclusion, a few words as to the theory of commutation. Broadly, it is possible to classify commutation under two heads, the one dependent on the powerful reversing action of the trailing pole tip (in a dynamo), the other which takes place in the neutral zone. It is, of course, well understood that the neutral zone itself is not free from magnetic lines, but the field is only very weak.

The first system either requires a shifting of brushes with varying loads or special and unsymmetrical designs of poles or other similar contrivances, and can hardly be said to satisfy modern requirements—in the first instance, because the shifting of the brushes to suit the load is not practical: in the second, because it is not applicable to reversing machines.

A machine which shall be able to satisfactorily commutate at all loads within the no-load zone is what is now required.

The view is still extensively held that in order to obtain perfect commutation, it is necessary to work the teeth and air-gap densities up to very high values. As a matter of fact, the only effect of such a design on the no load zone commutation, is that it goes a long way to prevent an abnormal distortion of the field which might interfere with the commutation, but provided this distortion is guarded against in some other way, the air and tooth densities may be as low as desired without interfering with perfect commutation. If this were not so, how would it be possible to design a booster for instance, which, when carrying its full load current, and with fixed position of brushes, would commutate sparklessly over practically the whole range of its voltage from *nil* to its maximum? And yet there is nothing impossible in these conditions, and they have been met repeatedly.

The process of commutation is much too complicated to allow the hope of obtaining a safe criterion of it by means of some such simple rules. The American reactance voltage method for that reason falls very far short in this respect.

There is no doubt in the writer's mind that the first to point the way to the correct solution was Thornton Reid, in his paper read before the American Institution of Electrical Engineers in 1897. The subject was later taken up and dealt with mathematically in a most able manner by Mr. Fischer-Hinnen and also by Prof. Arnold.

The writer is glad of this opportunity to acknowledge his appreciation of these dissertations. They have proved of the greatest value to him in his subsequent researches on this subject.

The somewhat different practical results obtained by those who have arrived at solutions of this problem are no doubt due to the very difficult solution of the fundamental equation. The author has found it necessary to consider not only the action of one short circuited coil, but also the mutual influence of the several coils undergoing simultaneous commutation; this naturally complicates matters still further, and necessitates certain simplifying assumptions, the influence of which on the final result it is somewhat difficult to follow through, and this introduces a personal element which no doubt accounts for most of the differences.

The mathematical deduction of the results hardly falls within the scope of this practical paper, and we must restrict ourselves to the indication of the points which materially influence the commutation.

Since the commutation depends on the correct variation with time of the intensity of the short circuit current, the duration of the short circuit must play an important part in the process, and all those various E.M.Fs. or differences of potential must be taken into consideration which prevail during the short-circuit.

Further, the nature, intensity and variation of the field through which the short-circuited spool travels must be considered. In order to make commutation possible within the no-load zone, with fixed brushes, it is necessary to so choose these various values that the alteration of the commutating field with a varying load does not alter the short-circuit current sufficiently to produce a materially increased or decreased current density under the brush at the end of the commutation. To obtain a very wide range, it will, therefore, be best to so arrange matters as to obtain a little too great a density at no load, and a little too small a density at full load, the permissible limits of deviation from the normal mainly depending on the quality of the brush used, being considerably greater for carbon than for copper brushes.

The potential differences due to resistance of the commutated coil and contact resistance between commutator and brushes, are easy enough to ascertain.

A more difficult problem is the pre-determination of the E.M.F. of self-induction, allowing for the influence of mutual induction. All these vary very materially for each style of winding, and no general rule can be stated for their calculation. They play a most important part in determining the final shape of the short-circuit curve; it is, therefore, important to be able to control the values they are to assume. The handiest means for this control are variations of the polar embrace, of the shape of the pole-tips, and of the reluctance of the magnetic circuit, provided, of course, that the number of turns per coil and the shape of the slots cannot be altered.

Working on these lines, the writer has found it possible not

only to design new machines very closely, and with absolute certainty as to their commutating qualities, but has found himself in a position to suggest with certainty what alterations would be necessary in the case of machines which had not given satisfaction.

It was originally his intention to extend the tables he has given up to about 200 B H.P., but lack of time forces him to postpone their publication to a future date. The writer regrets this the more as it is only in those larger sizes that it becomes possible to obtain the best utilisation of material as far as weight per KW. is concerned, as we are then able to work closer to the limit set by commutation to the A.T. per in. circumference.

ON A NOVEL WAVE DETECTOR.

[By a Berlin Correspondent.]

One of the most important instruments in any wireless telegraph system is the apparatus serving to reveal the presence of electric waves. While many improvements have been realised in the way of obtaining a better tuning between the sending and receiving apparatus, the endeavours so far made with a view of finding a highly-sensitive wave detector have only been successful in a few cases.

Most of the indicators so far used are based on the so-called coherer and anti-coherer principles, where the action of electric waves on the resistance in passing from one body to another is utilised. According as this action consists of either an increase or a decrease of the resistance, the apparatus is termed anti-coherer or coherer respectively, the latter being the most usual type.

Other instruments, such as, for instance, the well-known Fessenden wave detector, utilise the thermic effects of electric waves and the oscillations in the resistance of bolometer wires so produced. The most recent principle has finally been applied by Marconi; according to a suggestion by Rutherford, the former, a year ago, designed a wave detector resembling a small magneto-electric machine with a soft-iron armature, receiving a small amount of residual magnetism at each half revolution, which through the action of the impinging electric waves is made to disappear, as may be ascertained in a conveniently arranged telephonic circuit.

None of these devices are of sufficient accuracy, apart from their limited durability and the inconvenience of using motor-driven machines, as in the case of the Marconi detector. In an apparatus first produced in connection with this year's Wireless Telegraph Conference in Berlin, and just brought out by the Berlin Gesellschaft für Drahtlose Telegraphie, Mr. W. Schloemilch uses therefore quite a novel principle, consisting in a hitherto unknown fact, namely, the sensitiveness of polarisation cells with regard to electric waves.

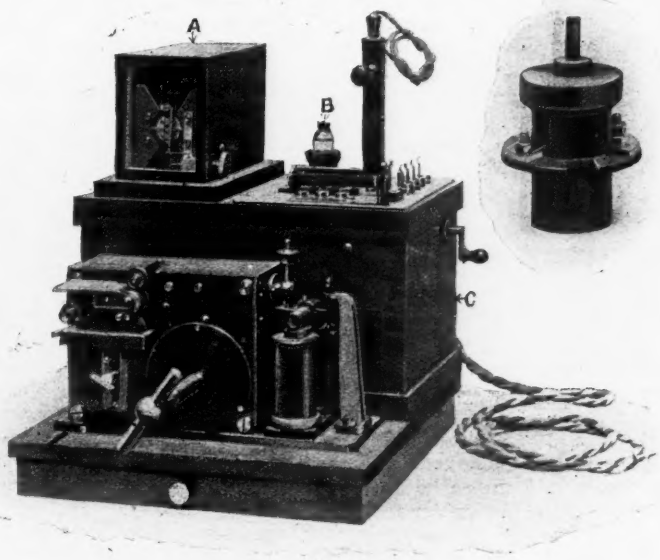
In the course of his investigations of the behaviour of polarisation capacities with regard to electric waves, the inventor noted that if an ordinary polarisation cell with platinum or gold electrodes immersed in dilute acid is connected with a source of current, the electromotive force of which is a little higher than the back E.M.F. of the cell (so as to have a slight evolution of gas on the electrodes in virtue of a permanent decomposition current), an ammeter inserted into the circuit would give evidence of an increase in the current strength as soon as the cell was struck by an electric wave.

As this effect proved to be the higher, the smaller the dimensions of the positive electrode, the definite type of apparatus contained positive electrodes 0·001 mm. in diameter and 0·01 mm. in length, while the negative electrodes, being of no essential importance, may have any desired dimensions and shape.

It is impossible, at the present moment, to make sure what is the physical nature of the phenomenon in question, and whether the detector embodies a capacity or an ohmic resistance. There is a critical pressure, different for each individual detector, for which the sensitiveness is highest. At the same time, there is a strengthened evolution of gas bubbles on the electrode as the electric waves strike the same; this is most strongly marked in the case of the critical pressure and maximum sensitiveness. By choosing as electrode materials two metals as distant as possible in the series of pressures, so as to constitute a small galvanic cell, the auxiliary battery may even be dispensed with.

One of the most important advantages afforded by this novel wave detector is its property of reacting to wave impulses, proportionally to their intensity, thus showing a reaction even with low intensity waves; in fact, it will never abruptly cease to work as other types are known to do. On the other hand, its constancy and insensitiveness to shocks should be mentioned, nor should the advantage of readily regulating the sensitiveness of the cell by altering the pressure be omitted.

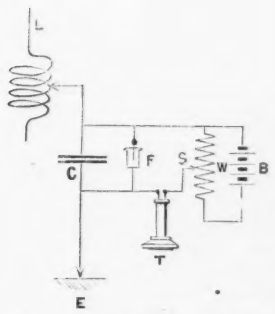
The instrument may be put to various, both practical and scientific, applications. By virtue of its special properties, it may be used for measuring wave intensities and comparing the intensities of the radiations given off from different sending devices; moreover, the physical nature of the spark in the exciting spark-gap can be ascertained by its means. On the other hand, the well-known drawback met with



A, Relay; B, Polarisation cell; C, Auxiliary battery, &c., in box.

Fig. 3.—Complete Receiving Apparatus.

Fig 1.—Polarisation Cell.



B, Battery; C, Condenser; E, Earth; F, Detector; L, Antenna; S, Regulator; T, Telephone.

Fig. 2.—Diagram of Connections.

especially in granular coherers—viz., the liability of the instruments to become over-excited, resulting in serious disturbances, will be eliminated in the new instrument, which reacts the stronger the higher the intensity of the impinging waves. Moreover, there is no necessity of using highly sensitive relays, as in the case of most of the other detector types, it being sufficient to note the Morse signals through the telephone.

The question as to whether the cell constitutes a capacity or an ohmic resistance being so far unsolved, the inventor has not yet been able to establish any definite arrangement of the detector circuit. The tuning of the receiving system is, as a matter of course, susceptible of the same accuracy as in the case of other instruments. A suitable arrangement is shown in fig. 2, where B is an accumulator battery, the circuit of which is permanently closed through a shunt, F the detector, T either a telephone or a relay, S a sliding contact regulating the pressure, L the antenna comprising some self-inductive windings, C a variable capacity inserted in parallel with the cell.

The detector, as shown in fig. 1, is inserted in a small hard rubber protective case. A longitudinal perforation, in connection with a tightening piece of rubber tubing at the mouth of the perforation, serves to prevent any liquid from leaking, while the gases are allowed to escape freely. A view of the complete receiving apparatus is given in fig. 3, this form of apparatus being suitable for use with both relays and telephones, whereas another special form of apparatus is specially designed for telephonic records.

REVIEWS.

The Elements of Electrical Engineering. A First Year's Course for Students. By Tyson Sewell. Second Edition, Revised. London: Crosby Lockwood & Son. Price 7s. 6d.

That a second edition of this work has been so soon called for, indicates that a book dealing generally with the principles of electrical engineering is in demand. There are really very few books of this nature which meet the needs of the student; they are either too general or scrappy, or too mathematical. The author of the book under review steers an intermediate course, and whilst treating his subject in a truly scientific spirit, he does not overburden the pages with abstruse mathematics or comparatively useless formulæ.

We should judge from a perusal of the book that its writer is a successful teacher. It is most unusual to find a writer who can explain so accurately, and at the same time so clearly, electrical units; and the author is to be congratulated on his treatment of this section of his book.

The chapters on circuits, the effects and measurement of the current, instruments, &c., are clearly written, and call for little comment. In discussing practical details of manufacture, or practice, the author is not treading on such familiar ground. The illustration of an armature with a hexagonal shaft, as shown in fig. 139, is somewhat out of place in an up-to-date book, nor is the method of end connections, shown in figs. 140 and 144, in accordance with general practice.

The brush-holder shown in fig. 189, the only one shown or described, is used by one manufacturing firm only, and it would have been better to show other types more generally used.

The author's slight acquaintance with practical work is further shown in his comment on the Admiralty temperature limit for dynamos; this, and the other inaccuracies pointed out in our review of the first edition, are repeated in the second. It is clearly the author's idea that 30° F. is the limiting rise of temperature allowed by the Admiralty, and that this should be taken one minute after the machine has stopped. As a matter of fact, this 30° F. is the limit allowed *within* a minute after stopping, and is really a measure of the cooling effect of the air. After this first minute the machine may rise to 70° F. above the atmosphere, and still pass the Admiralty requirements.

A feature of the present edition is the addition of three chapters dealing with alternating currents. It is, of course, impossible to avoid mathematics altogether in discussing alternating current phenomena, but the author has, by the free use of vector diagrams, kept mathematics down almost to the "irreducible minimum."

Generally the descriptions are both clear and accurate; but a three-phase motor with short-circuited rotor would take more than two or three times the full-load current at the moment of switching on. The current would be more like five or six times the normal value, assuming the motor to be switched direct on the mains without resistance in the rotor or stator circuit.

Throughout the book, examples bearing on the various chapters, are worked out, many of these being taken from the C. and G. Examination Papers on Electric Light and Power. There is also an Appendix containing over 80 questions and answers.

The book is one that should be of much service to the students for whom it is written.

Fowler's Electrical Engineer's Year-Book, 1904. Manchester: Scientific Publishing Co. Price 1s. 6d. net.

This useful work has been thoroughly revised, and numerous corrections have been made, while much of the text has been re-written, and new sections added. A directory giving particulars of 500 installations of electric lighting and traction is included. The book contains a great variety of useful information, which we are pleased to see is well up to date, and so far as we have checked it, is correct. A very wide field is covered, embracing practically all branches of electrical industry, save electro-chemistry and telegraphy, and the book can be recommended as a valuable work of reference.

Light Railways Procedure: Reports and Precedents. Vol. II. By J. S. Oxley, M.A., assisted by S. W. P. Beale, B.A. London: P. S. King & Son. 1903. Price 21s. net.

In the present volume is given a continuation of the reports contained in the first volume, and an appendix containing precedents taken from the latest orders. As such, the work forms a reference book of great value to the promoters of light railways and "tram railways," as the author styles lines which, for part or the whole of their length, use the public streets; the latter, it may be noted, considerably outnumber the former.

In the introduction the author draws attention to the hardships imposed upon promoters of light railways in competition with existing railways, where it is decided that Parliamentary sanction must be obtained, as the Commissioners can only reject the application wholly, and all the steps already taken are wasted. Another deterrent to the promotion of light railways, especially where a railway company is the promoter, is the compulsory purchase clause; an example is given, however (Midland Railway Co., Burton—Ashby Light Railways), in which, though the purchase clause is retained, provision is made compelling the purchasing authority to lease the undertaking to the railway company. This may become a precedent of considerable importance.

It is stated that the question of liability for injury to gas and water pipes by fusion or electrolytic action is now quite settled, the only protection afforded being that of the "Joint Committee" clause, which enjoins that reasonable precautions shall be taken to avoid such injury, compliance with the regulations prescribed by the Board of Trade being accepted as satisfying the requirements of the clause.

Undoubtedly the cases cited, and the copious information contained in the appendix as to procedure and precedents, model forms of light railway and "tram railway" orders, &c. (which constitute one-half of the volume), will be of great value in preparing applications for powers to construct such railways.

Compressed Air. By W. C. POPPLEWELL. Manchester: The Scientific Publishing Co.

Though electricity has displaced air for many purposes of power transmission, there are certain uses for which air is not merely greatly superior, but its superiority has been increased by the aid of electricity. Such a book as the present has, therefore, a distinct use. It is a sound and practical little work on the subject, dealing very briefly with the historical side of its subject and very fully with practice, various air compressors being illustrated with sectional views. In Chapter VI. air motors are dealt with. The questions of wet and dry compression are entered into; while freezing, water deposits, and other practical points are explained. Reheating, so important to economy, is dealt with.

Appliances and tools, also the displacement pump, are illustrated, and their working described. We should like to have seen a chapter on pumping by compressed air on the Pohle principle, for very little is known of this system, which, we think, might become more common if it were applied on more scientific lines.

There is a chapter on pipes and accessories and reheaters.

Chapter XI. deals briefly but sufficiently with the calculations appertaining to compressed air and with stage compression; Chapter XII. deals with efficiency tests.

A final chapter discusses questions of power transmission, and a few diagrams are appended.

The omission of all reference to rock drills is curious, and should be remedied, especially as there is a large demand for these appliances; the English-made "Little Hercules" drill is said to occupy the premier place among these energetic pounders.

Annual Report of the Chief of the Bureau of Steam Engineering, 1903. Washington: Government Printing Office. 1903.

This year's Report contains nothing of special interest to any engineer; it is chiefly administrative. The only engineering matter is a lengthy table of U.S. Naval vessels, giving their boiler grate, and heating surfaces, I.H.P., coal endurance at 10 knots, and weight of machinery, &c.

COMBUSTION AND TEMPERATURE DILUTION.

BY W. H. BOOTH.

IF practice may be taken as a guide to beliefs, there must be prevalent a very erroneous idea as regards the question of combustion and the subsequent letting down of temperature to a point at which the hot gases can be applied. The point has come to the front in respect of the question of superheating.

With clean boiler plates, almost any temperature can be admitted to one side of a plate on the other side of which flows a stream of water. It is likely that the best cooling effect is secured when the water is at the temperature of ebullition, owing to the latent heat capacity of the steam formed on but swept off the plate surface.

If after leaving the furnace the hot gases could all be reduced to atmospheric temperature, then the efficiency of fuel utilisation would be 100 per cent. With good combustion the efficiency falls below 100 solely by reason of radiation loss and of waste gas temperature.

So far as regards the dilution of temperature by means of excess of air, it matters nothing whether such excess of air within a certain maximum that will not reduce the temperature too low for proper combustion, is admitted through the fuel or through a damper behind the furnace bridge. The result is the same. Given 1 lb. of coal containing 14,000 B.Th.U., burned with 15 lbs. of air, the result will be 16 lbs. of gas at a temperature of, say, $100x°$. By employing 31 lbs. of air, the result will be substantially 32 lbs. of gas at a temperature of very closely $50x°$. There is exactly the same amount of heat present. Let it now be assumed that the heat thus generated is applied to a Green economiser or to a boiler, each apparatus rejecting the waste gas at 600°. Then, in the one case, there will be 16 lbs. of gas at 600°, and in the second case there will be 32 lbs. of gas also at 600°. The heat units sent to waste are exactly double. In practice they will usually be more than double, because the large volume of gas has less time to give up its heat to the boiler surfaces.

This final rejected heat and the waste it causes are the matters the significance of which does not seem to be grasped by those who so lightly advocate the combustion of fuel on bad lines, or, rather, it should be said, the faulty use of temperature. Let two examples of good and bad practice be taken to illustrate this important matter. In order to avoid calculation of temperatures, and enable these to be correctly assumed, the weight of fuel will be algebraically stated. The first case shall be, then, of a unit of fuel producing 30 lbs. of gas at a temperature of 2,400° above atmospheric temperature; a superheater that can take gas at 1,200° and reject it at 600° also above atmosphere. It is desired to find the proportion of heat utilised (1) when all possible heat is used, and (2) where the practicable temperature that the superheater can bear is secured by dilution, the air necessary for dilution being a second 30 lbs.

We have obtained from each unit of coal, say, 12,000 units of heat (arbitrary, not B.Th.U.). In the furnace, therefore, per unit of fuel, in the first case, there are 30 lbs. of gas, 12,000 heat units, and a temperature of 2,400°. One-half the heat is abstracted usefully, or otherwise. Turned into the superheater, there are therefore 30 lbs. of air at 1,200° containing 6,000 units.

Again, half the heat is abstracted by the superheater; and the rejected gas, still weighing 30 lbs., goes to waste at 600° of temperature with 3,000 units of heat. This loss is one-fourth of the heat value of the coal, and the fuel has been used at an efficiency of 75 per cent.

Let the case of dilution be now put. Leaving the furnace with 12,000 units and a temperature of 2,400°, the addition of 30 lbs. more of cold air enables the engineer to send on to the superheater 60 lbs. of gas at 1,200° of temperature, and carrying 12,000 heat units.

This 60 lbs. of gas goes to waste, as in the first instance, at 600° with 6,000 heat units; that is to say, one-half the heat of the coal is thrown away. Instead of utilising 9,000 units, only 6,000 have been used, and the heating power of the waste gas is no better, for its head of temperature is the same as in the first case, and the vast volume of excessive air is simply a hindrance to draught, and a choker up of flues and chimney.

Let there now be assumed the case of a unit of coal burned to 13 lbs. of gas, and yielding a temperature of 3,600°. In this case the dilution scheme involves trebling the total gas, but by the first system, two-thirds the heat is abstracted prior to the superheater, which is entered by the gas at 1,200°, as before, and containing 4,000 heat units. The gas still rejected at 600° carries away half of this 4,000 units, or 2,000 units, showing a total efficiency of fuel utilisation of 10,000 or 83·33 per cent. With the system of dilution there will be $13 \times 3 = 39$ lbs. of gas at 1,200°, containing 12,000 heat units turned into the superheater, and of this, one-half is rejected at 600° with 6,000 heat units.

By the dilution scheme one-half the heat must be wasted in every case, because this is the ratio of the initial and final temperature of the superheater, the first being the maximum that the tubes of the dilution superheater can stand, and the second being the rejection temperature which it is found in practice cannot well be reduced. Thus one-half of each pound of coal is used to give superheat to the steam, and one-half goes to useless waste. In the better practice, each pound of coal gives a fourth of its heat to the superheater, in the first case of a poor furnace, and in the second case it gives a sixth.

More coal has to be burned to secure the same amount of superheat, but where there is a use for the coal it is as well burned in the furnace of a superheater as in the boiler.

By correct practice a superheater may be made to save about one boiler in six by reason of the economy secured at the engine. It may be made to save a second boiler by reason of the fact that the coal that would be burned in this boiler is burned instead in a superheater which stands on the ground occupied by the second saved boiler. With the system of air dilution, the one boiler may be saved by the engine economy secured by superheat, but the second boiler must remain, because the superheater can only burn such coal as is required for the purposes of superheat, and cannot possibly have any heat to spare. In a boiler plant employing superheat, it is always easy to use all the surplus heat above 1,200° to 1,400°, because it is good steam practice to heat all the feed-water to the full temperature of the boiler, leaving to the boiler the duty of latent heat provision only, *i.e.*, of evaporation. It has long been known that a hot feed will save 5 per cent (or, perhaps, 10 per cent. with fully hot feed) in better boiler efficiency.

To raise high-pressure steam requires, say, 1,100 B.Th.U. per lb. To give high superheat requires 111 B.Th U. additional, or 10 per cent. The superheater that does this will, therefore, be capable, if properly designed, of adding, say, 220 B.Th.U. to the feed-water, which is equivalent to one-fifth of the 1,110 B.Th.U. in the saturated steam; or in other words, the special addition of heat to the feed-water would represent the work of one boiler in five as above.

The only safe way to calculate effects in steam engineering is to start from a basis of thermal units.

Endless confusion and errors creep in otherwise. At no time is this fundamental principle more necessary than when dealing with the mixed problem of combustion and waste gases, for there will otherwise be a hopeless tangle of thermal units, gas weight and temperature. Indeed, this hopeless tangle has already been responsible for the errors of the common design of chain-grate stoker, with its unlimited air admission.

The system of diluting temperatures by air admission could never have been invented by any man who had worked out the effect in thermal units. Assuming that superheating requires as above 10 per cent. additional heat above saturated steam, it is clear that this additional heat of 10 per cent. is accompanied in the dilution system by a waste of an equal amount. Put in another way, if 10 tons of coal are burned to raise saturated steam, there must be burned 2 tons to superheat it. Of this 2 tons only 1 ton is used, making 11 tons used in all. In actual practice the efficiency by the dilution system is rarely more than 40 per cent., if even so much.

If superheat saves 20 per cent. of steam at the engine, the net fuel will be 8 tons plus 2 tons, or 10 tons. With a proper system, the

superheat would represent 1 ton only, and there would be no second ton wasted, and a saving of 20 per cent. at the engine would mean only 8 tons + 1 ton, or 9 tons in all. In actual practice there are greater savings effected even by the unscientific system of air dilution, but in any case the net result of a correctly designed superheater must be in fuel alone 10 per cent. greater than the maximum saving by the incorrect system.

It cannot be too clearly understood that, in the production and utilisation of heat, the only way in which it is permissible to reduce temperature is by transference to the object ultimately to be heated. It would be different in a degree, if our useful means of employing heat enabled us to reduce all waste gases to a temperature of 50°, or even 100°, above the atmosphere.

To manufacture a high temperature in order to use the heat primarily at a low temperature is to destroy so much expensive fire-brick unnecessarily. If a low temperature is wanted, and must be obtained simply because there is no useful absorbent of high temperature heat, it were better to let in the diluent air at the furnace so as to preserve a temperature of 2,000° than to generate heat at 3,000° with needless stress on the brickwork, with subsequent dilution to a lower temperature.

There is a wide-spread impression that, by some sort of dodging, coal may be burned correctly and efficiently to give low temperatures. The heat is claimed to be baffled in some mysterious manner. If looked into, it will always be found that these methods of mystery resolve themselves into dilution with excessive air or into extinguished combustion with soot. The temperature of combustion is always $\frac{H}{w\,s}$, where H is the calorific capacity of a unit of fuel, w is the weight of gas produced by that unit, and s is the mean specific heat of the gaseous products. Moreover, the efficiency of utilisation of the fuel is inversely as the weight of rejected gases. These are Nature's laws, and as we cannot go behind them, we may as well endeavour to act in accordance with them.

SOUTH LONDON TRAMWAYS.

A paper was read before the Institution of Civil Engineers on this subject on Tuesday, 12th inst., by Alexander Millar, Assoc.M.I.C.E., of which the following is an abstract:—

The paper first gives a short sketch of the events which led up to the adoption of the conduit system of electric tramways for the central portion of London, and states the reason why a centre conduit was chosen in preference to a side conduit. The lines of which the re-construction is described are those known as the "Tooting Lines," extending south of the River Thames from three northern terminii, at Westminster, Blackfriars, and Waterloo Bridges, to a southern terminus Tooting. The route length of the lines in question is slightly over 8 miles, and the length of single line 16¾ miles.

Dealing with the roadwork and permanent-way construction, the paper describes first the structure of the conduits which are 2 ft. deep × 1 ft. 2½ in. wide. This consists chiefly of cement concrete and cast-iron yokes, the latter spaced at 3 ft. 9 in. intervals, which support the slot-rails and form a template to which the concrete panels are moulded. Chambers are formed at intervals of 5 yards, for the reception of the insulated supports from which the ⊢-shaped conductor bars, supplying current to the cars, are hung. These insulators have a porcelain body in appearance like an inverted jar, and are protected and secured in an iron cap, which is bolted to the slot-rails. The steel rod which carries the conductor bars is cemented to the inside of the porcelain cup, and the actual attachment to the bars is made by means of cast-iron clips capable of adjustment by means of an eccentric washer. The conductor bars have a sectional area of 2·15 sq. in., and, under test, they have given $\frac{1}{7{\cdot}14}$ of the conductivity of Matthiessen's standard of pure copper. The separate insulated supports were subjected to a 2,000-volt alternating pressure in the shops, and after erection in place the whole electrical system was subjected to a similar test between conductor bars, and 1,000-volt alternating pressure between conductor bars and earth. The bars are placed symmetrically in the conduit 6 in. apart, and the minimum air-gap between the conductors and conduit structure is 2 in.

Drainage of the conduit is provided for by connecting it to the sewers at intervals of 60 yards. These connections pass through a settling chamber, which intercepts the mud from passing into the sewers. The slot-rails are supported by the yokes, and the track rails by an 8-in. concrete bed, and both are held to gauge by tie-bars fixed to projecting lugs on the yoke head. At junctions and crossings steel castings take the place of the rolled rails, and specially wide yokes are used to embrace the converging conduits, and to support the track-rails as well as the slot-rails. The mechanism for operating the slot and track points at junctions is contained in a concrete pit built immediately underneath the track. Both track points are fitted with 8-ft. movable tongues, which are connected together to the slot leaves by a series of cranks and adjustable links, so that the whole can be moved in unison by inserting and manipulating a lever either in a box in the footpath, or alongside the track. The free end of the slot leaves is bevelled off, so that a car trailing through can push over the points without any external assistance. A feature about the work is that at no part is the slot wider than ⅝ in., and the arrangement for maintaining this at points and elsewhere is described.

The paving material, except in the margins which are laid to suit the existing material in the street breasts, is of granite setts, bedded on cement concrete, jointed with bitumen and cement mortar.

The line is divided into half-mile electrical sections, each half-mile section being fed by separate distributors, connected to the sub-station switchboard bus-bars, the positive through a maximum cut-out and ammeter, and the negative through an ammeter only. By means of these appliances, and a double-pole change-over switch, a perfect control of each section of the line is maintained. The current is generated by two 1,500-kw. continuous current sets erected in a station at Loughborough, from which feeders convey current to the three sub-stations at the Elephant and Castle, Brixton and Clapham, and are connected direct on to the bus-bars. The normal difference of pressure between conductors at the main station is 625 volts, and on the line approximately 550 volts. The method of dealing with faults on the line is described, and diagrams and drawings are given to show the method of connecting up the conductor bars at junctions and crossings.

The collection of current is effected by an arrangement called a "plough," which is suspended from horizontal transverse girders fixed to an extension of the side frames of one of the car trucks. The actual contact is made by two cast-iron shoes, mounted on a wooden diaphragm at the bottom of the plough-shank, and pressure is maintained against the conductor bar by the aid of flat steel springs. Flexible copper fuses, set to blow at 200 amperes, connect the shoes to the copper leads which are laid in chases, inside the plough-shank. From the lead top terminal cables are taken to the car-motors. The cross girder of the carrier, from which the plough is hung, has open ends, and is so designed that in the event of a plough taking the wrong road at points, it can travel to the side of the car and drop off without causing any damage. In its normal position the plough can be released by withdrawing a bolt, which frees a hinged tap, and allows the plough to slide down out of the guide.

The last part of the paper is devoted to a description of the operations, and deals with the difficulties attending the work of reconstruction, and the methods of handling the work. The paper is accompanied by numerous illustrations and by an appendix giving the comparative cost of electric conduit construction as compared with cable conduit construction.

ELECTRO-GAS SIGNALLING INSTALLATION ON THE MAIN LINE OF THE NORTH-EASTERN RAILWAY.

Few subjects demand more urgent consideration than the adoption of efficient signals for the safe running of railway trains. On the introduction of the railway system the necessity for two all-important safeguards was at once apparent: first, a proper system of signals for warning the engine driver of danger ahead; second, apparatus to enable the driver to stop his train in the shortest possible distance. The latter, it may safely be presumed, has now reached a point where further improvement will be unimportant so long as the friction between wheels and rails is the limit of retardation. In Great Britain, where the block system of signalling was first developed and its use enforced by the Government, it has been found that where traffic is at all heavy the signal cabins, to afford absolute safety, must be located so close together that the cost of their maintenance is a serious item of expenditure; but for some years it has been evident that, by the substitution of electrical power for the somewhat archaic and complicated mechanical apparatus now used, a complete revolution in the mode of working signals and points can be effected. Automatic signalling, although in extensive operation over long stretches of line in the United States, has, until within recent years, been almost unknown in British railway practice, the only important example of its use being on the Liverpool Overhead Railway. As is well known, an installation of low-pressure pneumatic signalling has for some time been in operation on the London and South-Western Railway, whilst in the course of a few weeks the North-Eastern Railway Co. will bring into operation a section of their main line—from Alne (a few miles north of York) to Thirsk—a distance of about 11 miles, equipped with the "Hall electro-gas" signalling. This installation will be quite an innovation in European railway working, as until quite recently with the Hall system of automatic signalling, as in operation in the United States, the semaphore signal was worked by an electric motor; but now carbonic acid gas has been adopted as the motive power, and it is this form of signal which will be introduced on the North-Eastern line. Fifty pounds of liquid carbonic acid gas are stored in a cylinder, 8½ in. diameter × 8 in. high, which is placed at the base of each signal post, and at a pressure of 800 lbs. per sq. in.,

this, however, being brought down by a reducing valve to a working pressure of 40 lbs. per sq. in. The gas is admitted into cylinders containing pistons attached to the upright rods. The valves controlling the admission of the gas into the cylinders are opened and closed by the armature of an electro-magnet, which is energised in the usual way by a local circuit controlled by the relay of the track circuit. The Hall system, which has not hitherto been adopted by any British railway, is designed to enable the services of signalmen, except at points of junction, to be dispensed with, and is purely automatic, being operated by means of connections set up by the trains themselves. On the stretch of the North-Eastern Railway where the work of installing the automatic signals is now nearing completion, there are six signal boxes, including three junction boxes. With the automatic signalling, one of these boxes will be entirely dispensed with, two will be closed (except when shunting operations have to be performed at the stations), whilst the three junction boxes will be closed when traffic on the branch lines ceases. The signals at all five places will be automatic at all times, whether the boxes are open or not. Each of the sections will be about 1,200 yards in length, and the carrying capacity of the line will thus be more than doubled. For the automatic signalling it is claimed that it presents the "block" system in perfection by supplanting human intelligence by exact mechanism, whilst in addition to increasing the carrying capacity of a railway by enabling the block sections to be shortened, it materially reduces the wages bill, by the abolition of a number of intermediate boxes now so necessary with the existing mechanical system of interlocking.

GAS-POWER FOR CENTRAL STATIONS.

MR. J. R. BIBBINS, in a paper read before the American Institute of Electrical Engineers, New York, December 18th, 1903, gives the results obtained at a large number of stations using various qualities of gas, both for steam raising and engine driving, and showing the economy resulting from the direct combustion of power gas in internal combustion engines.

The four contentions upon which he offers his testimony are :—

1. That present gas-power machinery is suitable for central station service.

2. That a well-equipped gas-power electric plant can operate with far better economy than a steam plant under similar conditions.

3. That its operation is much simpler and requires less running expense for the same results.

4. That a gasworks, labouring under low load or output factor, can profitably install a gas-power electric generating station and become its own largest customer, selling both gas and electricity at competitive prices.

From the results of the working of 12 plants having an average of about 315 B.H.P. capacity, employed for lighting and power purposes, he shows that all classes of generators are capable of being satisfactorily run by gas engines, including polyphase generators running in parallel, and demonstrates the economy obtained by replacing steam engines by gas engines.

In regard to continuous running, he instances a 65-H.P. two-cylinder vertical gas engine running for 8,230 hours out of 8,472, and of the 3 per cent. time in which the engine was not in operation, only 0·6 per cent. of the total time was attributable to the machine.

The engine ran for 1,157 hours without stopping, and was then shut down to repair a belt. Other engines operate 96 to 98 per cent. of elapsed time. In central station works there is usually ample time for any inspection and repair. No special skill is required for operating a gas plant.

In cost, the gas engine equipment is quite comparable with that of a steam plant; especially is this the case when condensers, heaters, pumps, &c., are considered.

In economy of fuel the gas engine admittedly has no rival, the steam engine and boiler giving about 16 per cent. thermal efficiency, while the gas engine at full load gives 25 per cent. and over. An important source of economy in gas plants is the fact that as soon as an engine is shut down all heat losses cease, and that there is no such loss as condensation in transmission of the gas from the producer. Gas engines can be started up, from cold, in from 40 seconds to a couple of minutes. As between 25 per cent. and 50 per cent. of the heat employed in the gas engine is carried off in the circulating water, where this can be employed for heating purposes the efficiency of the gas engine is greatly increased above that given.

Many classes of fuel gas are available for employment in gas engines, and when reduced to thermal value per cubic foot of explosive mixture the ratings are nearly equal :—

	Approximate B.Th.U. per cb. ft. Gas.	Mixture.
1. Natural gas... ...	1,000	91·0
2. Coal „	650	91·7
3. Water „	300	88·0
4. Carburetted water gas	600	92·0
5. Producer gas ...	120 to 145	60 to 68
6. Coke oven „ ...	600	90 0
7. Blast furnace gas ...	90	53 0

Blast furnace and producer gas will give within 16 to 20 per cent. of the power in the same engine that can be obtained from coal gas, but the lower quality of gas has the advantage of less tendency to pre-ignition, or "back firing," so that compression can be carried higher, with its increased economy. A comparison between two plants gave the cost of coal in the steam plant at 1·38 cents per KW.-hour, and in the gas plant 0·75 cents, or a saving of 45·5 per cent.

In the case of a plant first started on steam raised by natural gas, then converted to gas engines for driving, the saving in total operating cost amounted to 40·5 per cent., while though there was an increase of 30 per cent. in station output, the consumption of gas was reduced by 7 per cent. The paper gave further interesting comparisons and tables as well as curves showing efficiency tests, relation of cost of power to station output, &c., but want of space prevents our including them.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week.

Superheated Steam.

There is apparently but one point of difference between ourselves and Mr. Erith. In his practice, assuming that gases must enter the superheater at 1,200° and leave at 600°, he deliberately wastes half the calories in his fuel, but he appears to overlook this waste by some oversight. Let us follow 1 lb. of fuel containing 8,000 calories per unit weight as used on his system and on ours.

He turns the 8,000 calories into the superheater at 1,200° F. He absorbs 4,000 calories and throws away 4,000 calories at 600°. That is to say, he wastes the ratio of the final to the initial temperature by increasing his weight of gas in the ratio of the furnace temperature to 1,200°. In our method we secure, when producing gas at the rate of 19 to 1 of fuel, a temperature of, say, 3,000°. Though our superheater will take gas at as much as 1,400° F., for the sake of uniformity we will assume the gas to reach it at 1,200°, and to leave at 600°, as in Mr. Erith's case.

Then we must absorb $\frac{3,000 - 1,200}{3,000} \times 8,000 = 4,800$ calories in the feed heater, and we then send forward 3,200 calories at a temperature of 1,200° into the superheater, which absorbs 1,600 calories and rejects 1,600 calories at 600° F. Per unit of fuel burned we therefore reject $\frac{1}{2}\frac{6}{0}$ths as much heat as Mr. Erith.

True, we have only put 1,600 calories into our steam, and to secure the superheat of the same weight of steam as Mr. Erith we must have 4,000 calories. That is to say, in this particular case we must actually burn $2\frac{1}{2}$ times as much coal. But this is of no moment, for we burn it and use it as efficiently as though it were burned under a good steam boiler, and we do but transfer our coal combustion from the boilers to the superheater furnace. Thus by burning $2\frac{1}{2}$ times the coal usefully, we reduce our waste to only $\frac{2}{5}$ths that of Mr. Erith's per unit of the fuel. Mr. Erith loads up the

flues with probably 30 lbs. for extra air, or, say, 780 cb. ft., at the temperature, per pound of fuel to the detriment of the draught and the reduced efficiency of the economiser.

If the figures be worked out on a basis of 3,500° for furnace temperature, the result is even more favourable to us. Mr. Erith speaks of a fuel efficiency of 80 per cent. for his furnace. This is a trifle high, but let us admit it. It is absolutely useless to him when reduced in temperature, for the better his furnace result the more cold air he must admit, and no matter how he starts he cannot get away from the fact that he throws away in his waste gases the $\frac{t}{T}$ part of the calories in the coal where t is the final and T the initial temperature of the gases entering the superheater.

No small tube superheater can long bear an initial temperature above about 1,200° F. They will only stand this without burning out when they are so contracted in steam area that they lose from 15 to 20 lbs. pressure by frictional resistance. Our system of water control column does enable us to bear about 1,400° on the pipes, and we do not require to wire-draw the steam passing the superheater. We thus preserve the pressure, which is the measure of the capacity of the steam to do work. No superheater can reject its gases much below *about* 600° or higher. Hence the importance of keeping down the waste gases to a minimum weight in order not to waste calories.

Of course we turn practically as much gas to waste as does Mr. Erith, but ours is the waste of double or more coal. In short, we turn to waste, through the superheater only, as much gas at 600° from 2 or 3 lbs. of fuel as Mr. Erith proposes to do from 1 lb. of fuel.

Doubtless Mr. Erith expects to save one boiler in five or six as the result of the economy he would secure at his engine. Not only should we save this one boiler more easily than he would, but the superheater would take the place of another boiler. Where Mr. Erith saves one boiler we save two, with probably less total first cost of steam plant and increased fuel economy.

This is not a matter of mere apparatus: it is a matter of the principles of the science of fuel combustion, and it is beyond cavil that temperature dilution is most erroneous. Though we employ the heat of fuel as usefully and efficiently as if we burned it under boilers, we would gladly enough turn full furnace temperature upon the superheater tubes, for we should reduce the number we now require. But there is no suitable metal that will stand full furnace temperatures, and, in its absence, we turn the surplus temperature into hot water and steam, whereas Mr. Erith heats a lot of useless air, and sends the heat up the chimney.

About 1,100 B.Th.U. must be employed to produce saturated steam, about 110 B.Th.U. will superheat it by 200° to 220°, depending upon the yet uncertain value of the specific heat of steam. The additional heat is 10 per cent.

If coal be burned and used at 75 per cent. efficiency, its waste gases will flow away at 600° to 800° according to the furnace temperature secured. But Mr. Erith's efficiency at the maximum is but 50 per cent.

He must, therefore, burn 15 per cent, more coal in order to put superheat into steam produced in boilers which have an efficiency of 75 per cent. Even if he economises engine steam to the extent of 30 or even 40 per cent., his net coal economy will be 12½ per cent. or 17½ per cent. only, where it should be 22½ per cent. or 27½ per cent. No matter how regarded, it is impossible to get away from the wastefulness of temperature dilution by means of a foreign and ultimately wasted substance.

In the feed-water reheating process there is no waste of energy, as Mr. Erith wishes to infer. We take the feed from the "economisers," and raise it to the temperature of the steam before sending it forward to the boilers, thus turning the water-tube boiler into an evaporator pure and simple, as it should be. We complete the work of the "economisers," and reduce the work of the boiler, and in so far our water-reheating system may be classed with the boiler proper.

We claim to get by our system all the advantages which seem to be generally allowed to the flue-fired superheater over the independently fired superheater. As a fact, our superheater becomes to all intent a flue-fired superheater dealing with the steam and feed from and to a battery of boilers, and we claim to raise the evaporative efficiency of our combined apparatus to that of the best boiler practice. In superheater practice efficiency depends as much on head of temperature as on volume of gases.

Finally, may I add to this already lengthy letter a plea that questions of furnace work, steam raising, superheating and waste heat be all worked out on a basis of thermal units. To do so is to work on first principles, and to avoid numerous risks of error and many misconceptions. I am aware that the thermal unit is not popular even with engineers, and boiler-makers have been known even to swear at it.

W. H. Booth,
For the Cruse Controllable Superheater Co.

2, Queen Anne's Gate, S.W.

An Open Tender.

There was a Corporation
Not many miles from town,
The members of which body were
(It's rude to say) done brown.

It was an open tender,
And mentioned in the Press,
Applied for by the various firms
In competition's stress.

'Twas engines and 'twas dynamos
(The former were for gas,
And specified of one firm's make—
This in itself may pass).

The engines, each three of a kind,
Two hundred thousand watts;
(If their performance beats their price
'Twill knock off record spots).

The makers of the dynamos,
I trust with due remorse,
Got quoted price (*per* telegram)
At sixteen pounds per horse.

The station had already
Some plant of self-same make,
With dynamos of foreign build—
Please no exception take.

But, by a strange (let us say fluke),
As gambler's throw of dice,
The new same combination's just
Below the British price.

The engineers, apparently,
Are stickers to one make,
For all their towns are similar—
Perhaps for auld lang sake.

But why an open tender,
When they prescribe the same?
Each time to vainly estimate
Becomes a trifle tame.

Now, though this Corporation
Has got good plant, of course,
Still, the best engine may be dear
At sixteen pounds per horse.

And, though this is no poem,
For I am not a bard,
To show 'tis writ in all good faith,
I here enclose my card.

And, therefore, with a *nom de plume*
I this indite, you see,
And simply will subscribe myself
Yours truly, **P. P. P.**

Municipal Posts Filled before Advertising.

I wish to protest very strongly against a very prevalent practice of municipal authorities, viz., advertising an appointment as being vacant, when the man for the post has practically been selected even before the advertisement appears. I give a case in point. A short time ago the Leicester Tramways Committee advertised for a resident electrical engineer.

The advertisement appeared, I believe, in one paper and for one insertion only, with a very short time for the appointment to be taken up in, which, in itself, was rather peculiar. I inquired of a Leicester friend, with a view to applying for the post, but he said that it was useless, as it was practically arranged for a local man (the clerk of the works, I believe) to have the job, which has turned out to be correct.

Now, why should 50 to 100 people be put to the trouble and expense of sending in applications in a case like this?

I believe a Corporation is under no obligation to advertise a vacant appointment.

Also there is another common practice of giving most jobs that are worth having to a relation or friend of one of the councillors or officials, probably a pupil just out of his time, or a man with no real experience, instead of giving the post to the applicant who has had the best training, and the longest and most varied experience.

It is high time the Institution should bring this matter before the Board of Trade, who should insist that a chief or assistant engineer-in-charge of a public electric supply should have a training and experience commensurate with his responsibility, the same as a marine engineer's.

Disgusted.

[As announced in our "Central Station Engineer" column, the position at Leicester has been given to the chief electrical assistant under the borough engineer.—Eds. E.R.]

I have read a lot of letters in your paper on waste of energy in tendering. I would like to bring before your notice another form of waste energy, and, in my idea, quite as important as the waste energy of tendering—that is, in applying for positions advertised nowadays in the technical Press. I myself have applied for one or two positions advertised quite recently, and whilst granting there are better men in the market, it comes to my knowledge that these positions have been settled before ever notice of the appointment was published. I think this is grossly unfair, because it puts one in rather an awkward position to apply for a position, and have to ask his chief, or being a chief, his committee, for a testimonial, and then to find that the man is booked for the job. I know a few others who are in a similar position to myself, and I should like to hear what others have to say regarding this matter.

One of 'Em.

Information Wanted.

Will some of your readers kindly give me the address of celluloid merchants who make a speciality of celluloid sheeting about $\frac{1}{16}$ in. thick, perforated, corrugated celluloid, celluloid tubing, and vent plugs, for small accumulators?

Storage.

I should esteem it a favour if you would be good enough to inform me of the name of a publication which contains a table giving the "pitch" of the *brass thread*, which is in use generally throughout the electrical fittings trade. The thread I refer to is the accepted standard for lampholders, electroliers, &c.

G. Ellam.

London, *January 15th*, 1903.

Can you tell me the name of the makers of the Eclipse electric meter?

Supply.

Mechanical Trolley Ear.

I should be obliged if you could tell me how the trolley ear illustrated in the current issue is to be erected. If it were put on the wire before it is strained up it would be very difficult to get the ears in the right place, and if put on the strained wire it would be a very difficult job, besides straining the wire still more.

Enquirer.

Under ordinary working conditions, not in any case does the tension on the wire reduce the factor of safety below 4; it is more often 8.

The difference between the straight and the curved wire is $\frac{3}{8}$ in. It follows, therefore, that when this amount has been deducted from the ample sag per span, there will be no serious difference in the tension of the line.

With the aid of the ordinary stretching machine and the simple clamp used for bending the wire, there will be less difficulty attached to fixing these ears than with the ordinary sweating ear.

With the limited space at our disposal, we cannot give a more detailed account; but, should your correspondent or anyone interested desire further information on the subject, we shall be very pleased to place ourselves at their disposal.

For **Messrs. Rea & Reindorp,**
E.J.P.

East Ham, *January 19th*, 1903.

Walsall Switches.

I noticed a week or two ago some correspondence in your columns regarding the priority of the invention of a certain type of switch with adjustable laminated contacts. I do not wish to prolong this correspondence unnecessarily, but I would point out the desirability of inventors making some search before claiming, in a most conclusive way, novelty for their inventions.

One of the various forms of the adjustable laminated contact above referred to, was designed by the writer about six years ago, the principle being practically the same as that illustrated by the Walsall Co. in your issue of December 4th last. This switch has been manufactured by the firm for whom it was designed, right up to the present day, yet I have not the least doubt if one troubled to look up the Patent records, he would find their pages bristling with contrivances of a similar character, probably long before the present claimant ever thought of it.

The device, however, is not without its faults, one in particular is that the adjustment is not a parallel one, consequently the pressure is not equal on the surface of the contact blocks. In conclusion, I must say that the particular modification adopted by the Walsall Co. is the best one I have seen.

James Sugden.

Rugby, *January 18th*, 1904.

The Bristol Fire and Its Lessons.

In reading the account of "The Bristol Fire: Its Probable Cause, Effects and Lessons," which appeared in last week's issue, I find that Mr. Clothier gives as one of the obstacles which handicapped the speedy re-establishment of the supply, the time spent in obtaining light and examining the damage, and then again he asserts that some of the inconveniences caused by the absence of the light would be avoided by the systematic installation of flare lamps kept in a safe position and in regular order, so that they can be lit immediately there are signs of impending trouble.

It has occurred to me that it might be of interest in view of his remarks to say that, for a very long time, one of the rules in connection with these works which is most strictly and rigidly enforced is that, when dusk comes on a number of oil storm lamps are lighted, and kept in convenient places in case of a serious breakdown, which would throw the station into darkness.

Mr. Clothier suggests that the lamps can be kept so that they can be lighted as soon as there are signs of impending trouble. I cannot help but think that when breakdowns occur, very often the generating station is plunged into darkness immediately, and if the lamps are not kept lighted, not very much is gained. The oil lamps which are kept burning at these works throughout the hours of darkness, while they would not be of much use to carry out actual work by, would serve the very useful purpose of avoiding confusion at the outset, by preventing the station being in inky darkness.

I consider a mere glimmer of a light in the case of an emergency is often sufficient to stop this confusion, which is so liable to happen at the commencement of a breakdown which has to be dealt with in the darkness. In addition to these lamps, I have a change-over switch on to the station lighting, arranged in such a way that in the event of a shut down of the plant, the station lights are switched over directly on to the battery. Of course, in stations where batteries are not used, this cannot be done, but where batteries are installed, I consider it a very great safeguard indeed; on several occasions in Swansea I have found this arrangement exceedingly useful, and it is hard to overestimate the value of the same.

I send you the above remarks, as it has often struck me, in looking round different stations, that very inadequate provision is made for such emergencies as Mr. Clothier

had to deal with ; and his having been without light shows me, more than anything else, that the precautions I have insisted on so severely at these works are not without value.

C. A. L. Prussmann,
Borough Electrical Engineer.

Swansea, *January* 18*th*, 1904.

Several of your correspondents advocate duplication of the switchboard as a means of preventing total extinction of supply through fire. This seems a fairly obvious course, but at the same time it strikes one that if the switchboard and cable-races thereto are the most likely starting places for a fire (as stated by "J. B. F."), duplication will double the risk of fire. Of course it would be very little advantage for the purpose in view to have the boards close together, and, consequently, being at a distance, the risk of damage to the switchgear by fire from other causes would be largely increased.

Further, although duplicate boards might enable the supply to be resumed at an earlier hour after such a fire, they would not prevent discontinuity of service unless the duplicate board were worked by a mimic, who copied the actions of the main-switchboard attendant ; and at the same time duplicate two-pole switches were provided on each machine and each feeder, so that all could be cut off either board without going near it. This would cause a complication which would be practically impossible.

Haswell Bayly.

Slade's Green, Kent,
January 18*th*, 1904.

When an accident happens to the plant in a generating station, as a preventative, the duplication of the plant seems to be always advocated.

One of your correspondents now suggests that switchboards should be duplicated as the outcome of the Bristol failure. Duplication of H.T. switchboards, to my mind, means doubling the possibility of failures.

To maintain such a board would entail great expense, constant attention, and periodical testing.

Even if this were found to be practicable, I doubt whether there is an engineer in the country, with experience of H.T. plant, who would care to take the risk of changing over the supply on to such a board at a moment's notice. All that seems to be necessary is to provide for *the certain isolation* of each generator and feeder in case of failure.

Automatic oil break switches of the overload type, fitted with time limit attachments, can now be obtained, which are thoroughly reliable. Such a switch, fitted to each feeder, provides adequate means of isolation in case of failure.

For the alternators, on the other hand, the ideal arrangement would be to have similar switches of the reverse current type. To design a satisfactory reverse current switch, however, is a very complex problem, and at the present time, as far as I know, there is *no really reliable apparatus* of this type on the market.

I certainly agree with Mr. Clothier that to plug a machine directly on to the bus-bars is brutal. I further think that it would be exceedingly dangerous, as, in the event of a machine breaking down, a serious short would result, with no means of isolating the faulty section. Why not place on each generator an automatic oil switch of the overload type, the time limit of which could be set to just operate to prevent the generator burning out ?

Such a protection would do all that a fuse occasionally fails to accomplish, and also would cut out a faulty machine.

E. Garside.

Ferry Works, Thames Ditton,
January 19*th*, 1904.

Engineering has recently published some exceedingly technical contributions on the subject of high tension switchgear, in which it was clearly shown that other people had this apparatus to sell as well as the makers of the "cellular" type of switchboard. This being so, they came to the conclusion, as far as we can gather, that in the case of an arc starting on the "cellular" type of switchboard, the same would be completely wrecked.

A writer in your last week's article on the recent occurrence at Bristol clearly disproves the above by stating that the arc was confined to some three or four panels. We presume that there *are* a few panels still left intact at Bristol.

We have not noticed them in the photograph recently published showing the switchboard after the accident.

When electric lighting was first introduced, we understood that it was going to supersede the farthing dip, but it appears that the last-mentioned writer evidently thinks the candle and flare light should supersede the electric light, for central stations anyhow ! Are we to understand that flare lights and acetylene burners are in the future to be integral parts of the "cellular" type of switchgear ?

We have lately seen it suggested that storage batteries should be used to supply the load of large stations in the case of complete breakdown ; the writer of this latter article has evidently carefully thought this out, but why not spring a few shillings and buy a new power station, to be used only as a standby ? This writer evidently does not like the idea of candles in the lighting station.

We think the latter writer shows up better in his article on "Electric Travellers." There are possibilities of even this scheme failing. We have no doubt that the wobbling customer would be greatly impressed if an over smart station attendant should have a wrong idea of an $\frac{1}{8}$th of an inch. We think it probable that it would be a most difficult matter to approach a customer with the rim of his hat round his neck, where it has been more or less gently pressed by the armature on its downward course.

As regards business, this would depend upon how a man feels when he is talking through the roof of his hat.

Stalkie & Co.

In the course of Mr. Clothier's communication on this subject in your current issue, he mentions that "it will be obvious that some appreciable time, possibly three minutes or more, elapsed between the commencement of the outbreak and the cutting off the supply." This brings forward the importance of the point that every second of time saved in shutting down plant in such emergencies is of great value, and, in this connection, I think there is an apparatus which should be applied in many more cases than it is at present, namely, an automatic gear for closing the stop-valve of an engine.

In one form of such a gear, a powerful spring is wound up by the action of opening the valve, and is then prevented from shutting the valve by means of a catch. This catch is controlled by an electric battery circuit, either (1) automatically from the engine shaft by means of a centrifugal governor, to prevent excess of speed, or (2) independently by hand, a bell-push being used to close the circuit and release the catch.

By arranging the bell-pushes of the various gears in convenient positions on or near the switchboard, the engineer-in-charge is able to shut off the steam from any number of machines in the time taken by the springs to close the valves, which is something less than one second.

From my own experience, I can say such an arrangement is workable, and not excessively expensive in initial cost or upkeep.

W. N. Y. King, A.M.I.E.E.

Tramways Power Station,
Kelham Island, Sheffield.
January 16*th*, 1904.

Explosion of Enclosed Arc Lamps.

Perhaps some of your many readers would be able to throw some light on the following occurrence, which is, to me at least, rather puzzling :—

One of our large, long corridors here, which is lighted by four enclosed arc lamps of a very well-known make, is used as a combined day room and dining hall.

About 5.45 on last Friday evening, when the patients had left this room, the arc lamps were, as usual, switched off, there being a switch for each lamp placed on the wall near the lamp it controls. Somewhere between 10 and 20 minutes after the charge attendant and two or three others

who were in an adjoining room, were startled by a loud report, as of an explosion in the day and dining room, and on going to find out the cause, found the floor covered with glass; the charge attendant went to switch on one of the lamps, and immediately there was another, and, I believe, a louder report, and both the inner and outer globes of the lamp switched on were blown to atoms, some of the bits of glass being blown 30 ft. away. It was then found that the first report was due to the outer globe of another of the lamps having burst, but in this case the inner globe was not broken.

The last report was distinctly heard by the R.M.S., who was in the grounds fully 250 yards away.

There is no attempt to make the outer globes air-tight, so it does not seem to me possible that the explosion was simply a collapse of the outer globe due to vacuum when the lamps cooled. I may say that both the lamps in question had been feeding badly during the evening, but not so badly as to have them switched off.

I have since examined both lamps, and found them in perfect order with the exception of a little grit, which prevented the carbons from feeding freely.

C. T. E.

January 18th, 1904.

[It is well known that the inner globe of enclosed arc lamps becomes full of carbon monoxide after the lamp has been burning some little time, and the characteristic blue flame of the gas burning with oxygen can often be seen when the air leaks in immediately after use. Possibly a quantity of CO had accumulated in the outer globe, and, air entering as the lamp cooled, would form an explosive mixture. What ignited the mixture in the outer globe of the first lamp after such a long interval as 10 or 20 minutes we cannot say, but the effect of switching on the second lamp was obviously to ignite the mixture in both globes.—Eds. E.R.]

The "G.B." Surface Contact System.

In the article dealing with the "G.B." surface contact system which appeared in your issue of the 15th inst., you speak of the difficulties which might arise at complicated crossings over which, it is assumed, cars would have to "coast." May we point out that it was owing to the necessarily fragmentary and brief description of the system given at the demonstration that this idea has arisen. There is, in fact, no difficulty in getting a perfectly steady supply of current on the car, even at the worst junctions, and in this respect, our unipolar arrangement of magnet and collector is of great assistance. The plan adopted is as follows:—

The track rails are made of manganese steel at all points where they lie in the line traversed by the collecting chains. The collectors are, therefore, not attracted down into contact with them, but remain about 1½ in. above. In this way the most complicated crossings are easily negotiated without any interruption of the current supply to the cars.

Trusting that you will be able to find space for this explanation.

The "G.B." Surface Contact Co.
B. H. Bedell, *Engineer.*

Hamilton House, Bishopsgate Street, E.C.
January 19th, 1904.

The Education of an Electrical Engineer.

In your issue of January 15th appear two advertisements: one, for an electrical machine designer required by the City and Guilds of London Institute to give instruction in the theory and practice of electric machine design, construction and testing. Salary £150.

As designer for one of the largest firms in England, manufacturing direct and polyphase current machines, I am conjecturing what sort of an instructor Prof. Ayrton will obtain, to speak with authority on so important and scientific a subject. A man with commercial knowledge in designing should be selected to bring up our budding engineers in the most up-to-date and useful practice of modern design—especially in alternating-current work. Now, how many of our really good men would undertake this duty for £150 per annum?

The other advertisement—An instructor required for a Correspondence Institute; permanent and progressive position, commencing salary £250 per annum. Are the two advertisements compatible?

Here is a Correspondence Institution offering more for qualified teachers than one of our leading London ones. Which will obtain the better men?

I heartily endorse the views of my former instructor—Dr. W. G. Rhodes—in the attitude he adopts. Never has the Salford Technical Institution had a better teacher, and yet, how could they expect him to stay at the totally inadequate remuneration offered?

The remedy is surely in the hands of the Institutes. If the future generation of British electrical engineers is to keep its position as compared with Germany and America, higher salaries must be paid to the teachers; otherwise, the best experienced and most capable men can never be obtained to train the minds of the young.

S. H. Smith.

Leeds, *January 18th*, 1904.

A Canadian's Complaint.

Notwithstanding the general cry of "bad trade," it seems that the English manufacturer is not going to shift himself to improve matters. I am in want of a small telephonic apparatus, and, if able to procure same, should be able, in a short time, to place orders for large numbers of them.

I have written to several firms on the matter, and explained what I want, but the gist of all the replies amounts to "We have only got our regular lines."

Is there any firm in England that is open to go a little bit out of their way to secure orders? If so, I should be glad if you, Sirs, would act as medium, and forward their names to me should they send in answer to this. In my own country I could get what I want made quick enough.

The difference between English and American manufacturers is, that the latter say "Tell us what you want," and the former, "This is what we've got."

Canadian.

Birmingham, *January 16th*, 1904.

Electric Shocks on Flat-Back Switchboards.

My attention has been drawn to a letter in the Electrical Review of the 8th inst. on the above subject by Mr. F. Heppenstall. I have been much amused at his production, and am astonished that he has not been more accurate in some of his statements. As I claim to be the "unfortunate man" who met with the accident, it must be admitted without doubt that I should, and do, know more of the circumstances of the case than any other person, and I ask your indulgence for space in which to lay before your readers the true facts. First, the cause of the accident.—Faulty switchgear and appliances therewith, namely, in this case, the isolating plugs were not fitted vertically as should have been with the bus-bar and the panel switch, and the plug extractor, which was not by any means a fit for the top of isolating plug, which tool is supposed to be in the form of a bayonet catch. These plugs were got out with difficulty, to make the panel dead; but after adjusting the instrument on this panel, I mounted the board to replace the plug. I had worked with this same plug for about 10 minutes trying to get it home, when the extractor, not being a fit for the plug, slipped off and with the extra pressure to my left, I slipped into the trench on the top of the board, my left hand fell against the bus-bar, burning through the glove and severed the flesh from the hand between the forefinger and thumb. Springing myself from this position, my feet were brought into contact with the voltmeter contact stud and E-bar. This voltmeter having been displaced, and with my feet in contact with the aforementioned, I was unable to move in any way. I had the presence of mind to make use of my right hand, which was uninjured, to push myself off contact, and immediately I succeeded in doing this, I fell backwards on the floor, a distance of about 8 ft. I lay in this position as far as I can remember, for about half an hour before I regained consciousness. I was admitted into Dudley Hospital in less than an hour from my accident. I may also state here, to those interested in this case, how the current affected me. I had, with the first flash, a burn to the bone between

the forefinger and thumb, and after springing into contact with the voltmeter stud and E-bar, on my right foot on heel and forefoot, had a wound 2 in. diameter and ⅜ in. deep into the flesh, and on my left heel similar wounds. I was greatly affected with my spine long afterwards; this was not through the fall, but by shock. My wounds are not healed perfectly yet, but far from it, as they are only covered with tissue.

I am perfectly satisfied, in my own mind, the accident would not have occurred, had the parts been efficiently examined before being dispatched from the works; the removal of the plugs in question would have been an easy task, and, with reasonable care, unproductive of an accident.

Secondly, I would desire to give a flat contradiction to the statements contained in the latter paragraphs of Mr. Heppenstall's letter. I was, previously to the date of the accident, and had been, in perfect health, and absolutely deny that I had assured him that morning anything to the contrary. In fact, I had not seen him, nor did I until some days after, when I was in hospital, and I consider his remarks in the last paragraph unwarrantable, unkind, and untrue.

W. A. Guthrie.

Liverpool, *January* 16*th*, 1904.

Design of Direct-Current Machinery.

I am surprised that it did not occur to your correspondent, "A. B.," that his difficulty was probably only due to a misprint. Seeing the two formulæ side by side, and remembering that it was Mr. Steinmetz who pointed out that the hysteresis loss varied as the 1·6th power of the density per sq. cm., such a conclusion seems obvious enough. I must, however, take the whole blame for this mistake on my own shoulders, as I was given an opportunity of correcting the proofs.

If "A. B." thinks that the losses as calculated by the two formulæ given in his letter, bear any constant relation to each other such as expressed by his coefficient 58, he is, of course, mistaken. For one particular density (about 13,000 lines per cm^2) that relation may be as stated, but it will vary with varying densities, since in the one case the lines per cm^2 are squared, and in the other raised to the 1·6th power.

Val. A. Fynn.

Bradford, *January* 18*th*, 1904.

The Multiple-Supply System Patents.

Since the recent discussion on the above subject in your columns, two other patents have come to my notice, in which the essential feature of the multiple-supply system, namely, the use of two sets of motors on a train, one supplied from batteries on the train and the other supplied from the line, is described and claimed. These patents are No. 6,155 of 1897, taken out by M. Deri, of Austria; and No. 24,742 of 1902 (accepted in May, 1903), taken out by W. N. Stewart and H. E. Dick.

C. H. R. Thorn.

London, S.W., *January* 18*th*, 1904.

THE GREAT NORTHERN AND CITY ELECTRIC RAILWAY.

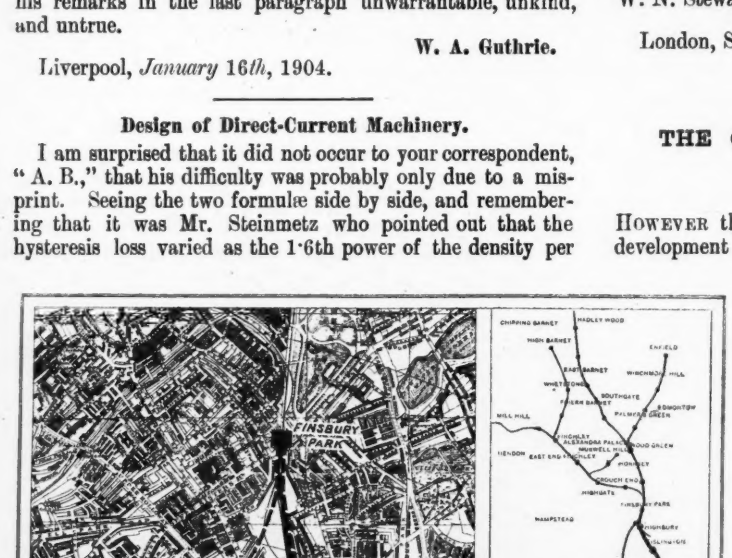
However this country was outstripped by others in the development of electric traction on tramways, it is certain that Britain led the way in the construction of electric railways, both underground and overhead; and though the equipment of our tramways passed for some time almost entirely into American hands, that of the great bulk of the railway work has always been carried out in this country.

The real pioneer in this direction was undoubtedly Dr. Edward Hopkinson, so far as the electrical engineering was concerned; it was he who carried out the little Bessbrook-Newry railway in 1885, and thus acquired experience which guided him in the equipment of the City and South London Railway, which was opened in 1890. Next came the Liverpool Overhead Railway in 1893, the engineers being Sir Douglas Fox and the late Mr. J. H. Greathead. The Waterloo and City Railway followed in 1898; up to this time the whole of the work was in British hands. The Central London Railway was opened in 1900, and the conversion of the Mersey Tunnel Railway was completed last year; both of these employed American engines, generators and electrical equipment.

In the Great Northern and City Railway about to be opened, we once more find almost all of the machinery of British manufacture; the same is true of the Liverpool — Southport, the North-Eastern, the Metropolitan, and the Great Western Railway contracts. Having regard to the immense importance of railway working to the electrical industry, it is satisfactory to find British works fully capable of furnishing all that is necessary to carry it out.

The Great Northern and City project was authorised by Parliament in 1892, Sir Douglas Fox & Partners and the late Mr. J. H. Greathead being once more the joint engineers, as on the Liverpool Overhead Railway; but several years passed before active steps could be taken to carry the Act into effect.

The capital subscribed amounted to £2,080,000, of which one-fourth was in the form of debentures. The contract for the whole of the construction and equipment of the railway



was placed in the hands of Messrs. S. Pearson & Son, Ltd., of Westminster, who have also undertaken to work the line for three years from the opening.

As will be gathered from the maps given herewith, the new railway forms a direct route from Finsbury Park Station, on the Great Northern main line, to the City at Moorgate Street; it is 3½ miles long, and will afford more ready access to the City than either of the existing railways approximating to the same route, which are indicated on the larger map.

The North London districts which will be served jointly by the Great Northern and the Electric Railways are shown in the small outline map, from which it will be seen that an enormous daily traffic may be expected. It is estimated that at least 17 millions of passengers per annum will be diverted from the tramway and omnibus services to the new line, while 10 out of the 30 millions of passengers arriving at Finsbury Park station on the Great Northern Railway will probably use the electric line, making a total traffic of 27 millions per annum at an early date.

The terminus originally planned was at Drayton Park station; here the lines come to the surface, to effect a physical junction with the Great Northern Railway. It was, however, found to be preferable to carry the line on to Finsbury Park, as the latter station, already congested, would have been quite incapable of accommodating the trains from the electric line in addition, without interference with the main line traffic of the Great Northern; the latter company provided funds to carry out the extension, which has now been accomplished in the course of 12 months, under great pressure, and without interfering in the least with the working of the main-line railway, although this runs over the large booking hall within a few feet—or even inches—of the roof of the latter! It is for the completion of this extension that the opening of the line has been delayed for a year.

At Drayton Park Station there are expensive repair shops, car depôt, &c.

Highbury Station, which also was an afterthought, is being constructed under the same Act that authorised the extension from Moorgate Street to Lothbury (now in progress), and will be completed without interference with the running of the line. Essex Road Station is near the Agricultural Hall. Old Street Station is an important traffic centre, and serves the needs of both the Great Northern and City and the City and South London Railways. At Moorgate Street, the surface station is opposite the City and South London Railway station, and near the Metropolitan station; here also there is a subway connecting the deep level platforms of the Great Northern and City, and the City and South London railways, affording ready means of transfer for through passengers between the north and south of London. The terminus of the railway will eventually be near the Bank at Lothbury, and the work of completing the extension to this point is being actively carried on.

Abundant facilities have been provided for the conveyance of passengers to and from the trains. At Finsbury Park the platforms are only 40 ft. below the rails of the Great Northern Railway, but in addition to ample inclines and stairways, large lifts are provided; owing to the lack of head room, these lifts, which were made by the Chester Engineering Hydraulic Co., are worked by hydraulic pressure, the water being pumped by electrically-driven pumps. At Moorgate Street and Essex Road electric lifts are used, made by Messrs. Easton & Co., of Erith. All the arrangements, in fact, are on an unusually large scale, the tunnels being 16 ft. in diameter, as compared with 11 ft. 8 in. on the Central London Railway, and 10 ft. 6 in. on the City and South London Railway, while the platforms are 450 ft. long at the termini, and 420 ft. at the intermediate stations. The tunnels were driven by means of an extra powerful Greathead shield, and for a great part of their length are lined with a blue brick invert and a cast-iron roof; it is believed that by this means both noise and vibration will be effectively diminished. The tunnels are lighted throughout from a source independent of the power supply, and the stations are provided with gas lighting for use in case of emergency—two features which are of the utmost importance in case of accident. Moreover, practically all the underground structures are fireproof, and there is a concrete gangway between the rails through the tunnels.

(To be continued.)

ENGINEERING STANDARDS COMMITTEE: ELECTRICAL CONFERENCE.

WE are informed that arrangements have been concluded to hold a conference of consulting engineers to large power schemes, and electrical manufacturers, to meet the members of the Committee dealing with the question of standardising generators, motors and transformers at 2 p.m. on Tuesday and Wednesday, January 26th and 27th, in the theatre of the Institution of Civil Engineers, Great George Street, Westminster.

The above Sub-Committee has, for a long time, been hard at work upon the question of the standard rating of electrical machinery. It has issued several carefully drawn up circulars to the manufacturers, the replies to which have been collated and very fully discussed, and these have proved of the greatest assistance to the Sub-Committee in the difficult task which it has in hand. Certain questions, however, relating to the standardisation of direct and alternating current motors have lately arisen, upon which great diversity of opinion appears to exist, as evidenced by the replies received. The Sub-Committee, after carefully considering the replies sent in, came to the conclusion that the most practical course of action, and that best calculated to lead to the most satisfactory results to all concerned, would be to confer with the leading consulting engineers and manufacturers and investigate to the fullest extent the different points at issue.

In view of the criticisms which have arisen as to the wisdom of adopting 25 and 50 periods per second as the standard frequencies, the Sub-Committee on Generators, Motors and Transformers, has also deemed it advisable to invite the consulting engineers and those interested in large power schemes to be present at this conference, and to discuss this very important question of standard frequencies with them. It is to be hoped that this conference will be well attended by representative men, with the result that, by carefully discussing these difficult questions in detail and from every point of view, the best interests of standardisation may be advanced by a distinct and substantial step.

The Council of the Institution of Civil Engineers has nominated its president, Sir William Henry White, to fill the place of the late Sir Frederick Bramwell as one of the representatives of that Institution on the Engineering Standards Committee.

LEGAL.

LLOYD'S PACKING WAREHOUSE *v.* VERITYS, LTD.

IN the King's Bench Division of the High Court on 15th inst., Mr Justice Jelf resumed the hearing of this action which was commenced at Manchester (see ELECTRICAL REVIEW, November 27th, 1903). The case for the plaintiffs was, that by letters which passed between the parties from October, 1901, to January, 1902, the plaintiffs agreed to buy, and the defendants to supply, certain electrical generating plant for £1,187. It was a condition of the contract that the plant should be capable of dealing with the maximum load required by the plaintiffs' motors and machinery, and should produce sufficient power to satisfactorily run the whole of the plaintiffs' motors and machinery then installed, or to be installed, at their works. The power was to be produced at a cost not exceeding 1d. per unit. The plant was supplied, and the plaintiffs paid £890 15s. on account. They found, however, that the plant was not in accordance with the conditions, and was incapable of dealing with the maximum load of the motors, and would not produce sufficient power to satisfactorily run them. They, therefore, rejected the plant, and asked the defendants to remove it. They claimed by this action for the return of the money paid for the plant, and also asked for damages for increased cost of plant and production.

The defence was a denial that the defendants agreed to the conditions alleged, and they said that it was an express condition that the plant should be capable of producing 51 KW. from the dynamo, and that this condition was fulfilled. They denied that the plaintiffs made known to them that the plant was needed to produce sufficient power to satisfactorily run the motors, and counterclaimed for extra work and materials supplied.

Mr. Pickford, K.C., and Mr. London represented the plaintiffs; and Mr. Horridge, K.C., and Mr. Acton the defendants.

Mr. T. E. Weaver, of Manchester, electrical inspector for the insurance company with whom the plaintiffs' motors were insured, said he had inspected the plaintiffs' works on three specific occasions, and he found the motors generally in order. He found no trace of neglect by the men who were using them for the work.

Mr. C. H. Wordingham, electrical engineer to the Admiralty, said he was called in by the plaintiff company at the end of 1902 in consequence of the generating plant supplied by the defendant company not working satisfactorily. When he examined the installation he found no trace of negligent use of the motors by the plaintiffs' workmen. In the course of a good deal of technical evidence which the witness gave, he stated that, by increasing the speed of the motor, more work was done than if the motor were running slower. The sawing plant which was installed at Lloyd's required a varying amount of energy. Each individual machine would require power varying according to whether the saw was rising or falling, cutting or not cutting. With a number of different machines performing different cycles of work in different periods, they would get a period of heavy load on different machines, sometimes synchronising and sometimes not. If they did not synchronise, the tendency would be to equalise the load, and when they did synchronise, they made the irregularity of the load on an individual machine greater. In the report which he made following his inspection, he criticised the average which Messrs. Verity adopted as the standard load. A gas engine was not capable of working at its full horse-power continuously and efficiently. If they attempted to work a gas engine of the type of the plaintiffs, continuously at its full power, that was to say, exploding every cycle, it would become too hot. It should miss once in every seven or eight cycles. When the full possible horse-power was 100, it should not be worked above 75; and a 75 H.P. would just do the 51 Board of Trade units per hour.

The hearing was again adjourned, and his Lordship expressed the opinion that, if possible, the case should be finished at Manchester.

Escott *v.* Newport Corporation.

Judgment in this case was delivered on Tuesday last week. Mr. Escott had brought an action against the Corporation in reference to a pole erected for electric tramway purposes, which penetrated the ground in front of his premises. His Honour Judge Owen gave judgment for plaintiff, but issued no mandatory injunction, leaving plaintiff to decide whether to claim for damages or for an injunction. The Corporation appealed against this judgment, and the *Western Mail* states that the Lord Chief Justice said that the Corporation had a right, under their statutory powers, to do what had been done, and the appeal must be allowed. Lord Justice Wills was absent, on account of a cold, but sent a written judgment concurring. Lord Justice Kennedy also concurred.

City of London Electric Lighting Co *v.* Nobbs.

In the City of London Court on Tuesday, before Judge Lumley Smith, K.C., the City of London Electric Lighting Co., Ltd., sued Messrs. John Nobbs & Son, tailors, 77, Finsbury Pavement, E.C., for £1 16s. 6d. for electric current supplied to Messrs. Friend & Co., one of their tenants in the same building, upon a guarantee signed by the defendants.

Mr. John Nobbs, the defendant, said that the guarantee was signed by his son (who was his partner) without his authority or knowledge. His daughter-in-law had invested a little money in the business of Messrs. Friend & Co.

The Plaintiffs said that they thought they were quite safe in taking a guarantee from the defendants, seeing that they were the landlords of the whole building.

Judge Lumley Smith, K.C., said it was not within the ordinary authority of a partner in a tailor's business to make his firm liable for electric light. There would be judgment for the defendant, but without costs.

Knight *v.* Isle of Wight Electric Light and Power Co.

Mr. Justice Joyce, on Wednesday, gave judgment in this vibration case, which has already been reported. He granted an injunction during the continuance of plaintiff's lease. The judgment will appear in our next issue.

National Telephone Co. *v.* Samuel.

This case came before a Divisional Court of King's Bench, composed of Justices Wills and Kennedy, on Monday on an appeal by the plaintiffs against a decision of the Deputy Judge of the Marylebone County Court, who had entered judgment for the defendant on the finding of a jury.

It appeared from the statement of Mr. Rostron, for the appellants, that the action was brought by plaintiffs against the defendant, Mr. H. Samuel, of Cleveland Square, to recover one year's rent of a telephone, &c., due in January, 1903, under a written agreement, which provided that the defendant should hire from the company a telephone, with a right to communicate with the other subscribers free of charge. The rent he was to pay, in advance, was £10 5s. a year for five years, the contract being dated January 3rd, 1900. By it it was provided that the company should maintain the telephone in good working order. For the first two years all went well, and the defendant paid his subscription at the beginning of 1901 and 1902, but in 1903 he refused to pay, and the company summoned him in the County Court. The defence raised was that the telephone instrument and line was not maintained in good working order as agreed, and defendant claimed that he had received no consideration from the agreement, and as plaintiffs had failed to perform their part of it, he asked that it might be rescinded. At the trial defendant gave evidence that in 1902 the service was very bad, and that the machine would not work for weeks. A friend of his also gave evidence, and in the result the jury stopped the case, and found a verdict for the defendant on all points. Thereupon, the judge made an order rescinding the contract, being of opinion that the plaintiffs had not supplied a reasonably efficient service. The learned counsel said that the judge should not have done this, as it had not been shown that there was a total failure of the service. In order to justify that decision, there would have to be a finding of the jury, not only that the company had failed to keep the instrument in good working order, and to supply a service, but that they had acted so as to show an intention to repudiate, or abandon, or refuse to perform the contract. That was not suggested from beginning to end of the case.

Mr. Niell, for the defendant, contended that the verdict of the jury, and the judgment of the County Court judge, should be affirmed. Unless the defendant was entited to the remedy which the County Court Judge gave him, he must go on paying for the machine which was a total failure for the last six weeks of 1902.

In the result, Mr. Justice Wills said he was of opinion that the appeal must be dismissed. He did not think that any jury would hesitate to find that such a service as this, which it had been admitted had to be remedied over and over again in 1902, and which at length broke down in November, so that it was no use attempting to use it further, showed that the company did not intend to perform their part of the bargain, and to give a reasonably efficient service. He thought the County Court Judge was right in rescinding the contract.

Mr. Justice Kennedy, in the course of concurring, said there was no doubt the real thing being fought out here was the question whether the subscriber was bound to pay in advance his subscription for the year 1903 and be bound for the future. That was what he was contesting—not damages for the past year or a return of his subscription. The jury must be taken to have found that he was really not getting a telephone service at all in any proper sense of the word—not that there was a want of care in keeping up the communication, not merely that there were some breakdowns not repaired with reasonable despatch; but that the subscriber was not getting that which was the heart and substance of the contract, namely, that he should, subject to certain temporary misfortunes, get a telephone service. The subscriber was not getting it, and the jury meant so to find. If the jury were right in finding there was that which amounted to an exoneration and discharge of the obligation of the subscriber, the learned judge was right in rescinding the contract.

Leave to appeal further was asked for, but the Court refused to grant it.

BUSINESS NOTES.

Book Notices.—*Technics: A Magazine for Technical Students.* London: George Newnes. Monthly 9d.—No. 1 of this new publication is before us, and, coming at a time when the subject of technical education is in the forefront among public questions, it is likely to receive considerable support. Quite fittingly, Lord Kelvin is selected for the frontispiece, though we must confess that we do not care much for the lately adopted style of magazine portraiture, which overweights a small page with too large and heavy a picture of a head, and gives practically that and nothing more. The articles in the January number which are of interest to the electrical student are these:—"Charlottenburg," the Berlin Technical High School, by Prof. W. E. Dalby; "Radium," by E. Edser; "Elementary Technical Education," by Sir W. H. White; but the chief among them all is a ten-page article on "The Continuous-Current Dynamo," by Mr. H. M. Hobart, with whose valuable contributions to the Electrical Review on kindred matters our readers are familiar. *Technics* has personal columns, an "Answers to Queries" section, pages devoted to the month's progress of science and technology, and the now indispensable competitions arrangements have been made. It occurs to us that the editor will require to exercise much discretion if he is to put enough in each issue to appeal to every individual class of student, and not overdo one section at the expense of another. We wish him and the publishers success.

Index of the Technical Press.—The appearance of No. 1 of Vol. III. prompts us to call attention again to this excellent index. Its operations cover all branches of engineering and all the engineering journals, while it is kept close up to date, references up to December 12th, 1903, appearing in the January issue. The references are very brief, but the originals are filed, and a cutting containing any desired article can be obtained from the publishers immediately; moreover, every reference includes an order number, decimal classification number, and indications of the length of the article and the price of the cutting. Each issue is also provided with a key index. The London office is 11, Queen Victoria Street, E.C.

Protection and Industry. By various writers. London: Methuen and Co. 1s. 6d. net.—The contents of this book consist of articles which have appeared in the *Manchester Guardian* from the pen of eleven different writers who have dealt with the subject from the point of view of particular industries. The authors are:—Sir Swire Smith, Mr. Walter Runciman, M.P., Messrs. Hugh Bell, S. G. Hobson, Arthur Wadham, Prof. James Long, Mr. Elijah Helm, M.A., Sir Charles McLaren, M.P., Messrs. William Burton, Alfred Mond, and "A City Editor." They unanimously declare in favour of free trade. The "Machinery and Engineering Trades" are the subject of Mr. Wadham's comments; Mr. Hugh Bell discusses the interests of the "Iron and Steel Trades"; Mr. S. G. Hobson deals

with the "Hardware and Allied Trades," and Mr. Alfred Mond with "The Chemical Industries." The general conclusion is summed up thus:—"The battle is to the skilful more than to the protected."

Willing's Press Guide, 1904. London: Jas. Willing, jun., Ltd., 125, Strand.—This is the 31st year of publication of this serviceable shilling Press directory. Its alphabetical section is its strong point, though the classified and geographical sections are also useful. It can justly lay claim to compactness, and for business men it is a convenient guide to all sections of the Press.

Hazell's Annual for 1904. London: Hazell, Watson & Viney, Ltd.—This is the 19th yearly issue of this excellent publication. It is edited by Mr. W. Palmer, B.A., and it is a cyclopædic record of men and topics revised to December 31st, 1903. There is a summary of electrical events in the "Scientific" section, and some reference to electrical undertakings appears under "Engineering." As a work of reference, *Hazell's* needs no commendation at this date.

"Die Drahtlose Telegraphie in ihrer Verwendung für nautische Zweeke," by Dr. R. Blochmann. Leipzig: B. G. Teubner. 60 pfg.

Motor-Driven Embossing Presses.—Messrs. Palmer and Co., of 42, Castle Street, East, Oxford Circus, W., have received instructions from the British and Foreign Blind Association of Great Portland Street, W., for an installation of alternating-current motors to drive six Furnival embossing presses. These presses are to be used for embossing in "Braille type" on damp paper, the Association's well-known publications for the blind. As an accessory to the above installation, Messrs. Palmer & Co. are constructing a novel electrically-driven steam paper-drying apparatus. The damp sheets of paper, after they leave the Furnival embossing presses, are placed on small wire trays attached to an endless conveyor chain passing over about 150 ft. of steam-heated pipes in a specially constructed chamber. The sheets of paper when dry are then removed from the machine and ready for binding. It is calculated that this machine will have an output of 1,000 dry sheets per eight-hour day, and will accomplish in 15 minutes the drying of sheets which had previously occupied two days. The whole of the apparatus has been designed, and is being specially made to suit the unique system of books and literature as provided by this Association, for the education and advancement of the blind. Messrs. Palmer & Co. have been busy with many other important works, and amongst the orders recently secured is the complete equipment of the studios and works of Messrs. Photolinol, Ltd., of Holland Park; "Adamson lights" being used in the studios and motor-driven photo-printing machines in the works.

Burnand Transformers for Tasmania.—The Burnand Transformer Co., Ltd., 6, Oxford Street, Regent Road, Salford, have just completed delivery of a large order for transformers for Launceston, Tasmania, comprising approximately 100 transformers with a total capacity of 1,450 KW. These transformers have all been tested and passed by Prof. Fleming without a single rejection.

Copper Castings.—Messrs. J. Tylor & Sons, Ltd., of 2, Newgate Street, E.C., have drawn our attention to the excellent results which they are obtaining in connection with copper castings for electrical purposes. In proof of this, they have forwarded a copy of a certificate emanating from the Westminster Electrical Testing Laboratory, relating to tests for specific resistivity carried out on two samples of metal castings recently, with the following results:—

	Sample No. 1.	Sample No. 2.
Resistance of a centimetre cube ..	1·883 microhms	1·885 microhms
Specific resistivity (copper 1·0)	1·110	1·111
Percentage conductivity (copper 100%)	90·08%	90·01%
Temperature, 60° F.		

These results are certainly remarkably good, and, having regard to the important applications of copper castings in electrical switch-gear, &c., they will doubtless be of interest to our readers.

Motors in Saw-Mills.—Electric saw-mills have been established at Close, Newcastle-on-Tyne, by Messrs. John Herring and Co. All the machinery is driven by motors.

The British Electric Car Co., Ltd.—The creditors of this company held an adjourned meeting on Thursday last week at the Mosley Hotel, Manchester, Mr. J. F. Wild, the liquidator, presiding. The statement of affairs was considered, and the chairman, in referring to the position of the company, said that the business during his appointment had inclined him to the opinion that there would be no further loss—in fact, it was likely to improve. The creditors' committee recommended that negotiations be entered into for the sale of the business as a going concern on such a basis as may be agreed between the receiver and manager and the committee. After some discussion, the committee's resolution was carried.

Annual Dinner.—The seventh annual dinner of the North Staffordshire Railway electrical staff was held at Stoke-on-Trent on the 7th inst., the superintendent, Mr. Andrew F. Rock, presiding.

Exports of Electrical Machinery.—The last month of 1903 has the largest total to its credit as regards the exports of electrical machinery, a total of £43,240 being recorded, bringing up the aggregate for the whole of the past year to £437,410.

Colliery Plant.—An order has been placed by the Ashington Coal Co. with the British Westinghouse Co. for a motor-generating set, consisting of a three-phase induction motor, driving a direct-current generator. The motor will run on a 40-period circuit at 480—500 volts, and 575 r.p.m., driving by direct connection the dynamo which, at 480—500 volts, will have a rated output of 200 KW.

Catalogues and Calendars.—From W. T. Henley's Telegraph Works Co., Ltd., we have received a wall calendar of the changeable last-for-ever description. The walls of many an electrical engineer's office will be adorned for some time to come with one of these useful date references.

A new pamphlet (No. 163) has been issued by the British Thomson-Houston Co. devoted to the Edison incandescent lamp.

Messrs. W. H. Willcox & Co., Ltd., of Southwark Street, S.E., have sent us one of their 1904 hanging date remembrancers.

The Morris Cohen Co., Ltd. (who have taken over the business of the late Morris Cohen, of 132, Kirkgate, Leeds, from the executors) have published a new list of their screws, bolts, and nuts (both Standard Whitworth and British Association threads), electrical terminals and binders, and a variety of other specialities of similar character, which they are manufacturing at their factory at Vulcan Works, Alfred Street, Leeds, which is equipped with every description of the latest types of automatic machinery. Special arrangements have been made to deal with motor-car requirements. Copies of the catalogue may be obtained by the trade upon application.

From the Lion Spring Co., of Oldbury, we have received circulars of their spiral, volute, scroll and flat springs. The company are represented in London by Mr. Sydney Smith, of 215, St. John Street, E.C.

We have received from the Fuller-Wenstrom Electrical Manufacturing Co., of 110, Cannon Street, E.C., a handy blotter with diary attached, including an insurance coupon against railway, tramway and cab accidents to the tune of a maximum of £1,000.

Messrs. Plutte, Scheele & Co., of 18 and 19, Queenhithe, E.C., who are London representatives for Messrs. Schmahl & Schulz, of Barmen, have issued a 16-page illustrated list of their lampholders, tumbler-switches, cut-outs, ceiling roses, counter-weight fittings, fuseboards, ball and spider fittings, and other specialities for electric lighting work.

Messrs. Clarke, Chapman & Co., Ltd., of Victoria Works, Gateshead-on-Tyne, have placed in our hands a copy of their latest catalogue of electrical machinery, which is arranged so that new sheets may be easily added as issued. Excellent pictures of their many classes of electrical plant appear, also very clear dimensional drawings with tabulated data respecting outputs and prices. Multipolar dynamos, semi-enclosed and open type motors, enclosed weather proof type C.C. motors, dynamos with combined bedplates ready for direct coupling to engines, high-speed vertical compound enclosed steam engines, condensing and non-condensing, single-cylinder vertical, and open type compound engines, combined open type engines and multipolar dynamos for ship lighting. A section of special importance is that containing some excellent views of the Clarke-Chapman electric winches for shipyard service and Admiralty boat and coal-hoisting, also electric windlasses, winding engines, and anchor capstans. Some pages are devoted to showing and particularising the various types of electric projectors which are made at the Victoria Works, and among the other lines represented may be mentioned electric works locomotives, tramway controllers, Admiralty power board, launch motors, and portable electric drills for workshop and shipyard use. Great care has been bestowed upon the preparation of the numerous photographic reproductions with which the lists are illustrated.

A new pamphlet has been brought out by the Empire Roller Bearings Co., Ltd., describing a special new series of the Empire roller bearers for shafting.

Trade Announcements.—Messrs. Robinson & Horsfall, consulting electrical engineers, have removed to more convenient offices at 13, Castle Street, Liverpool.

The British Electrical Trade Supply and Bitumen Co. have opened offices at 20, Bucklersbury, E.C., to which address all correspondence should be sent. The company's works are at Deptford, and they are open to supply bitumen, box compound, insulating varnishes, oils, grease, waxes, paints, and bitumen, boilers, troughing, tiles, &c., for cable work. We are asked to state that their name in the "Universal Electrical Directory" should read as given above, and not "The Electrical Trade Supply and Bitumen Co.," as printed.

The British Westinghouse Co. announce that they are now in a position to receive visitors at their new office at Market Place Buildings, Sheffield, which has hitherto been used only for correspondence. This office is in charge of Mr. C. A. Slater.

The Stirling Co., of Manchester, the original manufacturers of the Stirling boiler, announce that they have now opened a London office at 53, Victoria Street, Westminster, S.W. This new arrangement will enable them to deal more efficiently with their London and South of England business in water-tube boilers. This office will be under the charge of Mr. G. Graham. The head office will still be at 53, Deansgate Arcade, Manchester.

Mr. Alexander Ritchie has retired from the board of Messrs. McDowall, Steven & Co., Ltd., with whose London business he has been identified for 30 years and more. He is shortly to open extensive showrooms at Castle Baynard Wharf, 12 and 13, Upper Thames Street, E.C., as Alexander Ritchie & Co., ironfounders and hardware merchants; but until the completion of these new premises, offices and showrooms have been secured at 4A, Upper Thames Street, E.C.

The Schuler-Lahmeyer Motors.—The Lahmeyer Electrical Co., Ltd., announce that they have taken over the sale, for this country, of the Ferranti-Schuler alternating current single-phase motor (pending permanent settlement), which is specially adapted for lift and crane work. The Lahmeyer Co. has for some time owned the Continental patents, and has manufactured a good many of these motors for the Continent.

Bankruptcy Proceedings.—At the Dudley County Court on Monday, J. W. M. Storr, electrical engineer, Dudley, appeared before Mr. Registrar Young for public examination. Debtors liabilities were £319, and his assets nil. The examination was adjourned.

Dissolutions and Liquidations.—A petition to wind up the Elmore Trust, Ltd., is to be heard in London on January 26th.

The Rangoon Electric Construction Syndicate is to wind up voluntarily, with Mr. F. C. Ridley, 3, Prince's Street, Storey's Gate, S.W., as liquidator.

A meeting of the Electric Lamp Supply Co. is to be held at 31—34, Basinghall Street, E.C., on February 18th to hear an account of the winding up from the liquidator (Mr. A. M. Day).

Messrs. C. Hopkinson, B. Hopkinson and E. Talbot (Hopkinsons and Talbot, consulting engineers, Manchester and Victoria Street, S.W.), have dissolved partnership. Mr. C. Hopkinson will continue the practice at Manchester in his own name, and Mr. Talbot will, in partnership with Mr. A. D. Stevenson, continue the Westminster practice under the style of Talbot & Stevenson.

The Auxiliary and Light Railways and Tramways Co., Ltd, is winding up voluntarily, with Mr. F. G. A. Hitchcock, of 20, Victoria Street, S.W., as liquidator. Creditors should send particulars of their debts to him by March 3rd.

Electrical Time Service.—It is regrettable that a greater amount of attention has not been given to the question of electric time service, for the progress of this country in that direction is quite behind that of other countries. It is between four and five years ago that Mr. F. Hope-Jones, in his paper read before the Institution of Electrical Engineers in London, asked that the matter should be treated seriously as a branch—though no doubt a small one—of the profession, but the consideration that was then bestowed upon the subject has not been followed with any very great recognition of the benefits of uniform and accurate time. The Synchronome Co., of 32 and 34, Clerkenwell Road, E.C., which works under the Hope-Jones patents, has had its system adopted in about a dozen large engineering works, half a dozen electrical factories, the same number of public institutions and various printing establishments, schools, stores and factories in different parts of the kingdom, and those who wish to find out where the Hope-Jones system is in operation for their inspection can obtain a copy of a list which the Synchronome Co. has in circulation, giving the number of dials in use in each installation. The full details of the system, with numerous diagrams and other illustrations, are given in the company's 30 pp. catalogue, copies of which may be procured by applying to the address given above.

A Necessary Precaution.—It is reported that there has been some friction at the Westinghouse works at Trafford Park, owing to a vaccination order which was issued because of the importation of small-pox from Hyde.

LIGHTING AND POWER NOTES.

Aston.—The T.C. has decided to extend the E.L. mains, at a cost of £2,595.

Beccles.—The Southern District Electricity Corporation has notified the T.C. that it will not proceed with a prov. order this year for the lighting of the Council's area by electricity.

Bridgnorth.—Both the T.C. and the R.D.C. have decided to oppose the Shropshire and Worcestershire Electric Power Co.'s application for a prov. order for electric lighting in their areas.

Broomsgrove.—The U.D.C. has resolved not to assent to the North Worcestershire E.L. order, in order to obtain a clause to purchase the undertaking within a certain period, and other concessions.

Brislington.—The P.C. has resolved to recommend the U.D.C. to oppose the Keynsham E.L. order unless it is excepted from the provisions of the order.

Broxburn and Uphall.—The Bathgate District Committee has decided to light Broxburn and Uphall with electricity. Two schemes have been submitted, one costing £804, and the other £360.

Burslem.—The Tunstall U.D.C. has approached the T.C. with a view to Burslem supplying electricity in its district. It was recommended that the engineer be instructed to prepare two schemes, one for supplying electric light for Burslem and Tunstall, and the other for Burslem alone.

Burton.—On the recommendation of the Gas and Electricity Committee, the T.C. has resolved to apply for a loan of £33,477 for extensions, &c.

Canterbury.—After March 31st next the price of energy has been fixed as follows:—Lighting, flat rate, 5d. per unit, or on the maximum demand system, 7d. per unit for any number of units up to the equivalent of 100 hours per quarter, and 2d. afterwards; for power, 3d. per unit, with discounts.

Devonport.—An agreement has been signed between the Corporation Electric Power Committee and the Plymouth, Stonehouse, and District Tramways Co. for a supply of energy.

Dorchester.—The recommendation by the E.L. Committee, that application be made to the L.G.B. to sanction a loan for carrying out the scheme of electric lighting, has been defeated by a majority of two votes. The matter has been referred back to the Committee for further consideration, with the object of giving an outside company the opportunity of coming in to carry out a scheme.

Dublin.—The Board of Works has approved of the arrangements entered into by the Corporation for the supply of electricity to the State apartments at Dublin Castle. About 3,000 lights are required.

East Molesey.—The U.D.C. has sealed an agreement with Messrs. Edmundson's for the supply of energy in its district.

Edinburgh.—The E.L. Committee of the T.C. has recommended the provision of additional plant for the McDonald Road station at an estimated cost of about £9,000.

Farnham.—Replying to a communication from the B. of T., inquiring what steps the U.D.C. proposed to take to carry out its prov. order, the U.D.C. intimates that it does not intend to carry out the order at present.

Finchley.—The greater portion of the Main North Road has been equipped by the Council with Nernst lamps.

Foots Cray.—On the 20th inst. a meeting of the ratepayers of the U.D. was held in the Public Hall at Sidcup to decide whether to proceed with the prov. order obtained by the P.C., or to enter into a contract with the Bexley U.D.C. or the Woolwich B.C. for a supply of energy in bulk, and to consider proposals for erecting a power station within the U.D.

France.—A 60,000-H.P. electric-power plant has been decided upon at Saint Ouen, on the Seine. It is stated that Brown-Boveri-Parsons steam turbine sets of large H.P. are to be installed.

Gainsborough.—The Council has resolved to apply to the B. of T. for a prov. order for E.L.

Hetton-le-Hole.—The U.D.C. has been asked by the Sunderland and District Tramway Co., to grant its consent to the electric lighting of the district by the company. A deputation, after considering a similar application from the British Electric Traction Co., decided to lodge no objection against the Sunderland and District Tramway Co.'s application.

Houghton-le-Spring.—The U.D.C. has given its consent to the application of the Sunderland and District Tramway Co. for a prov. E.L. order.

Hove.—The T.C. has informed the Hove Electric Lighting Co., Ltd., that its charges for energy are excessive, and that the time has arrived for a material reduction in the price.

The L.G.B. has sanctioned the loan for the Aldrington E.L. scheme.

Jamalpur.—The East Indian Railway Co. are adopting electricity in place of steam at their large works in this town, the scheme being carried out under the direction of Mr. T. R. Browne. According to our contemporary, *The Indian Municipal Engineer*, three Belliss-Holmes 110-KW. three-phase alternators working at 220 volts are in operation. Electric cranes are being generally adopted throughout the works, the overhead traveller in the erecting shop having a lifting capacity of 30 tons; D.C. arc lamps are installed in all the shops, and for this purpose the three-phase current is converted in a motor-generator.

Kearsley.—The U.D.C. has decided to ask the Farnworth U.D.C. upon what terms it will be prepared to take over the Kearsley E.L. Order for a period of 18 or 19 years.

Leeds.—The Corporation is seeking powers to take over electricity undertakings outside the city, and to supply energy to local authorities and companies owning or running light railways or tramways, electrically equipped, within or beyond the city. This clause the Yorkshire Electric Power Co. opposes, as trenching on the powers already granted to them, and it also resents the proposal to prohibit the placing of any electric cables in any street in the city, except with the consent of the Corporation. The company has engaged counsel to oppose the Bill unless the clauses are considerably modified.

Llangollen.—A company, entitled the Llangollen and District Electric Light and Power Co., Ltd., has been formed, with a capital of £6,000, to carry out a scheme for the lighting of the town.

Musselburgh.—The agreement between the National Electric Construction Co. and the T.C. in connection with the electric lighting and tramways in the burgh has been signed.

Nairn.—Messrs. Crompton & Co. have declined to enter into negotiations with the T.C. in regard to its prov. order.

The Council has now unanimously agreed to enter into negotiations with the National Electric Construction Co. and also with Messrs. Edmundsons, Ltd.

The Lothians.—The Mid-Lothian C.C. has unanimously resolved to oppose the Lothians Electric Power Co.'s Bill.

(*Continued on page* 143.)

THE CONGRESS OF THE HOUILLE BLANCHE.

By MARCEL BLOCH, Ingénieur Civil.

The writer takes the opportunity, on the strength of a recent personal inspection of the works already described under this head,* for referring to the valuable experience gained in the operation of mountain plants, and summing up by quoting Mr. Bergès' personal opinion in the matter before proceeding to describe the largest electrical works afterwards inspected, to which must be attributed most of the fame of this country (France) as a water-power producer.

Mr. Bergès states, with reference to these high heads of water, that he would have no objection to utilising falls of from 1,200 to 1,700 metres head. It appears that the difficulty is not so much in the height of the fall or the nature of the water, as in the regularisation of the flow, which is extremely variable, owing to the inconstancy of the snowfall and the irregularity of the seasons during which the snow is melted and the flow from glaciers occurs, which contribute to mountain streams their uncertain character. Mr. Bergès has formulated elaborate plans also for the utilisation of some mountain lakes, which will allow a good regulation of the flow to be effected.

Our readers should present to themselves an idea of the surrounding country, which is mostly agricultural and difficult of access, communication being completely suspended during certain periods of the year. No large towns are to be found in the area which we are dealing with, and in consequence the distribution of power takes place on a rather limited scale and in small quantities. Grenoble, the only centre of importance, is situated some 11 kilometres from the Lancey Falls, but there are several installations afterwards referred to, nearer Grenoble, on the River Drac, which will be described in some detail, as they present some points of considerable interest.

Grenoble was the headquarters of the Congress, in view of its central position for this class of installations, and several visits were made to the Drac River plants. The city of Grenoble is lighted by the municipality, which owns the gas-works, and it will be apparent that considerable obstacles were placed in the path of those who sought to light the city by electricity. Certain installations on the Drac River, however, are to be adapted for this purpose. The Drac River is a very good example of an Alpine stream, with its torrential currents dwindling to almost nothing when the winter season puts an end to the melting of the snows. It has a number of large modern generating stations on its banks, which were mainly designed for electro-chemical industries, notably the production of calcium carbide. Owing to the severe competition in the calcium carbide trade, the production became unremunerative, and many

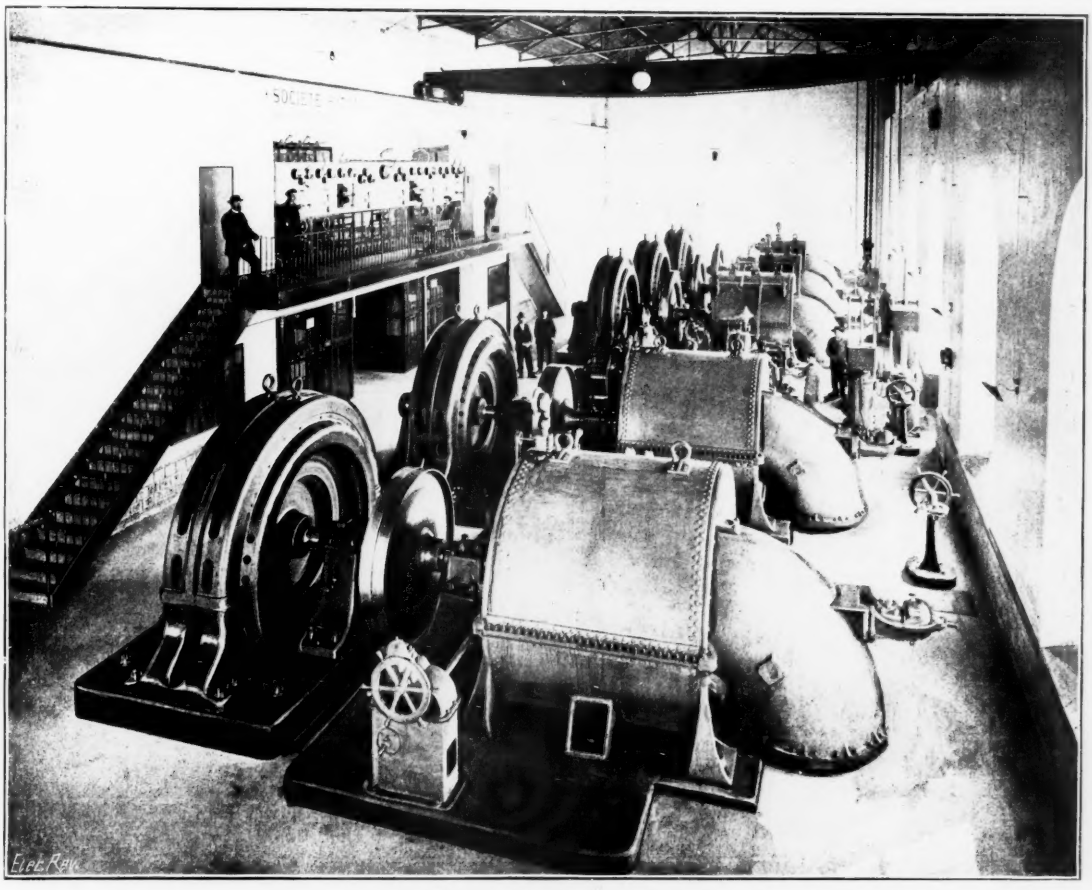


Fig. 1.—Interior of Champ Station.

* Electrical Review, Vol. 53, pp. 402 and 505.

stations were obliged to close their doors. The remainder were formed into a strong trust, which controls the French market, and, as a consequence, other stations were shut down to limit the supply in accordance with the demand. It will be remembered that great hopes were entertained of the trade some few years ago, but the demand for the carbide never came up to expectations. In fact, in France alone, there is enough machinery actually laid down to supply

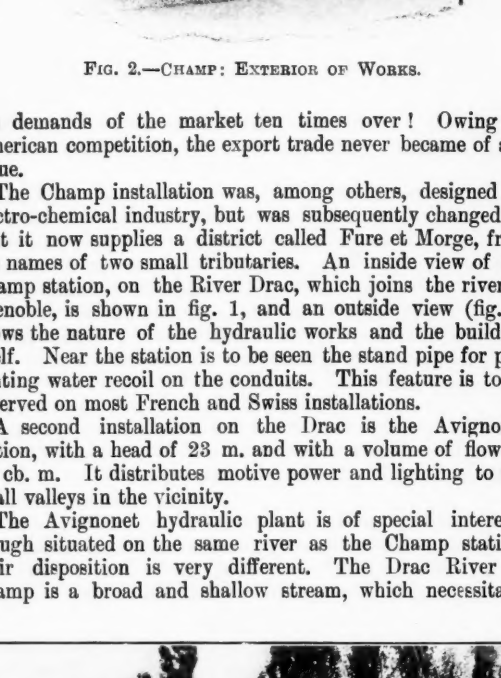


Fig. 2.—Champ: Exterior of Works.

the demands of the market ten times over! Owing to American competition, the export trade never became of any value.

The Champ installation was, among others, designed for electro-chemical industry, but was subsequently changed so that it now supplies a district called Fure et Morge, from the names of two small tributaries. An inside view of the Champ station, on the River Drac, which joins the river at Grenoble, is shown in fig. 1, and an outside view (fig. 2) shows the nature of the hydraulic works and the building itself. Near the station is to be seen the stand pipe for preventing water recoil on the conduits. This feature is to be observed on most French and Swiss installations.

A second installation on the Drac is the Avignonet station, with a head of 23 m. and with a volume of flow of 40 cb. m. It distributes motive power and lighting to the small valleys in the vicinity.

The Avignonet hydraulic plant is of special interest: though situated on the same river as the Champ station, their disposition is very different. The Drac River at Champ is a broad and shallow stream, which necessitates

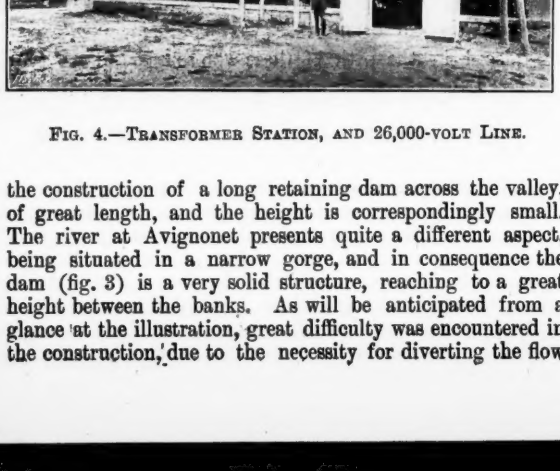


Fig. 4.—Transformer Station, and 26,000-volt Line.

the construction of a long retaining dam across the valley, of great length, and the height is correspondingly small. The river at Avignonet presents quite a different aspect, being situated in a narrow gorge, and in consequence the dam (fig. 3) is a very solid structure, reaching to a great height between the banks. As will be anticipated from a glance at the illustration, great difficulty was encountered in the construction, due to the necessity for diverting the flow of the river. This was done by substituting for the river bed a temporary discharge canal drilled through the rocky bank, as can be seen by reference to the figures.

Avignonet station is a typical high-pressure station for the transmission of energy and for lighting. The chief characteristic of the station is in the generators, which are wound for the terminal pressure of 26,000 volts. The construction and design of these machines does great honour to the Creusot Works, which is, as is well known, the largest iron foundry on the Continent. This firm made a very successful departure of its own, after having represented in France for some time the Ganz and Thury interests.

Electric traction in the neighbourhood has been developed by the installation at St. Georges de Commiers de la Mure, which is at present fitted for experimental purposes with a Thury D.C. locomotive running on the three-wire system under 2,400 volts. This installation is similar to that of the Grenoble—Chapareillan tramway previously referred to, except that the voltage is doubled. This, however, is cut in two by using two motors always in series between the outside

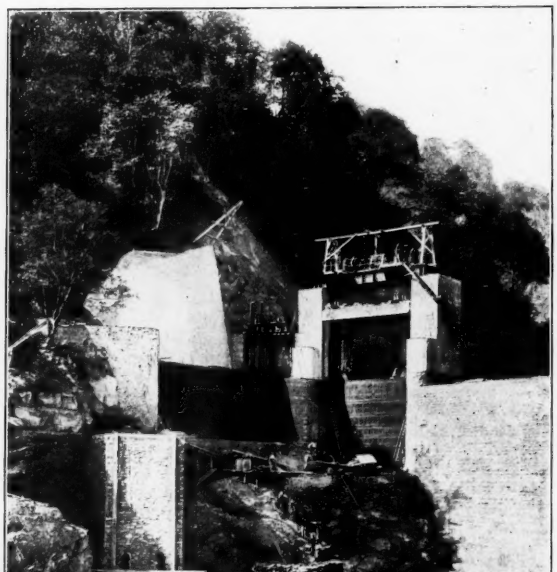


Fig. 3.—Head-works at Avignonet.

wires and the return wire or track. The locomotive derives its current from a special generating set in Avignonet station.

The 26,000-volt line is partly common to both plants, Champ and Avignonet, which is a rarity. A view of the line across the country, and a typical transformer station, are seen in fig. 4.

The Drac River, and its tributary, the Romanche, form between them a most flourishing delta, and are admirably suited for the utilisation of water-power. The district is the chosen home of the electro-chemical industry. We may mention the following, amongst others, as worthy of more than a passing notice :—

The Clavaux station, built by the Compagnie Universelle de l'Acetylene, has a head of water of 45 metres and a flow of 15 cb. metres. On the same river (Romanche) is the Riouperoux station, with a fall of 35 metres and a flow of 10 cb. metres. The works of this station form a paper factory. Fig. 5 shows a view of Livet station, with a height of fall of 60 metres and a derived volume of 25 cb. metre.s Quite a large and interesting installation is this Livet station, which was first equipped for electro-chemical industry, but is now preparing to furnish Grenoble with light and power.

It is worthy of note that the district of Grenoble already possessed a network of electrical distribution derived from a number of small stations, which were of rather primitive construction. The stations are rather interesting in their way, as they were among the first to be erected in France and mark an epoch in the electrical industry of the country.

At a distance of about 10 km. north of Grenoble is the Breda station, the construction of which is typical of the utilisation of torrential streams. It derives its power from a small mountain stream, a tributary of the Isère, and the head of water is 45 metres, with a volume of but 6 cb. metres.

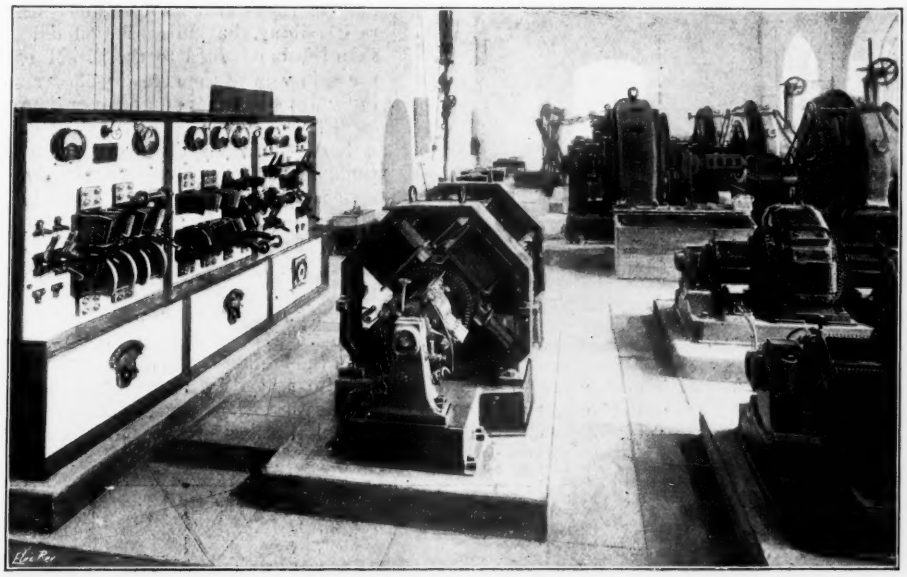


FIG. 5.—INTERIOR OF LIVET STATION.

Close by is another small power station, near the junction of the Breda River with the Isère. It is called Cernon station, and has a height of fall of 612 metres; the flow per second is only 200 litres. Another fall serving the same station has a height of 500 metres and a flow of 300 litres. These two stations supply the Grenoble and Chambery valleys with light and power, and the length of the transmission line is some 60 kilometres.

The Grenoble district is more particularly served by the Engins station, which is characterised by conditions very similar to those of the preceding small stations. Photographs of all three stations would be illustrative of conditions much the same, and we will therefore content ourselves by giving a view of the third one only. The head of fall is 282 metres, and the derived flow 300 litres. (Fig. 6.)

It has not been attempted to light Grenoble entirely from this small station, and the public and private lighting was until recently carried out by the municipal gas works. Th has now, however, been arranged a transmission from a large plant situated on the Romanche River, a straight line distance of 35 kilometres from Grenoble, for lighting the city. Mention of this Livet station was made in our general review of the Romanche River characteristic plants.

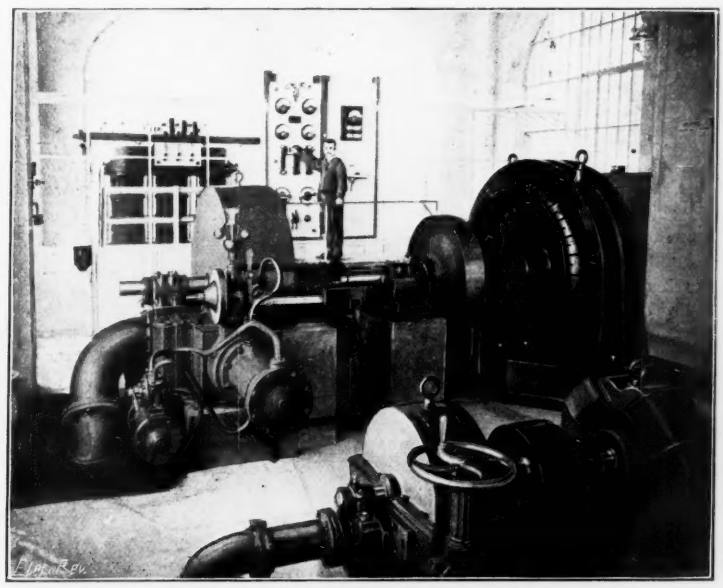


FIG. 6.—ENGINS STATION.

The Romanche River, however, has not a monopoly of large electro-chemical stations. Some very interesting plants are to be seen on the Arc River, a tributary of the Isère. Among the most interesting is La Praz, with an output of 12,000 H.P., engaged in the production of aluminium. There are two falls used, and their respective heights are 80 and 33 metres, each with a volume of 12 cb. m. per second.

A few kilometres below La Praz is Prémont, utilising a fall of 72 metres, with a volume of 5 cb. m., for the production of explosives. At an equal distance further down stream lies Calypso station, belonging to the Pechiney Co. This station uses falls of a height of 144 and 595 metres and a volume of 5 cb. m. The station produces mostly aluminium, and consumes 1,500 H.P. Another station on the same river is St. Michel de Maurienne, with a fall of 136 metres and 5,800 H.P. output. This station is also engaged in the production of aluminium.

About the same radius from Grenoble, near Moutiers, is the Volta station, also utilised for the production of aluminium. It has a fall of 75 metres head and a flow of 17 cb. metres. It belongs to a company at Lyons, and is used for the production of chlorine, potassium and sodium. The regular output is 13,500 H.P. The elaborate character of the installation, especially of the hydraulic work, is one of the main points of interest of the station. The large size water conduits are considered, with those of Clavaux, 3·5 m. in diameter, as most interesting, and the following figures will fairly illustrate the character of the plant (figs. 8 and 9).

Before leaving France and arriving at the Swiss frontier, we reach the Arve River, on which we have a series of three very interesting plants, those of Chedde, Servoz and Chavants. The first-named belongs to the "Société des Forces Motrices et Usines de l'Arve," and the two latter are the property of the Paris, Lyons and Mediterranean Railway Co.

The Chedde station (fig. 10) has a fall of 140 m., derived from the Arve, and a flow of 8 cb.m. The station uses this head and flow, and passes the same on by means

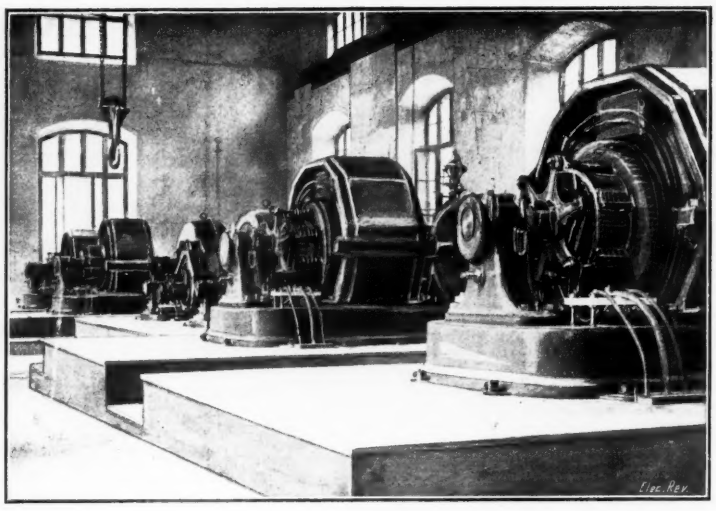


Fig. 7.—Interior of Servoz Station (P.L.M. Railway).

of another fall of 35 metres to the Servoz station of the P.L.M., which utilises the same volume under the remaining 35 metres head, as above stated (fig. 7). The hydraulic works of these two stations are somewhat similar in general details. Space forbids an elaborate description of the characteristics of these two plants, although much interesting reading might be given of the division of the responsibility, and the working in common of this fall, between the P.L.M. Railway and the Société des Forces Motrices. The latter company employs the Chedde station, with an output of 7,000 H.P., for the production of chlorate of potassium and a special explosive called "Cheddite."

The Servoz station and the Chavants plant both serve as stations of the P.L.M. Railway, and although a long description cannot be given, a short account of the installation will not be out of place.

The Hydro-Electric Plants of the Chamonix Railway.—The problem to be solved was the construction of a narrow gauge light mountain railway connecting the main lines of the P.L.M. Railway, along the picturesque route of the French Mont Blanc, with Switzerland. The grades were as high as 9 to 10 per cent., and the common solution in such a case would be the rack railway, but this solution did not seem the best suited to the P.L.M. engineers, in view of the necessity of operating the trains sometimes on grades or descents as well as on levels.

It was found that the necessity of a rack could be avoided by the use of a train control system specially developed by the engineers of the P.L.M., and the necessary adhesion of the cars could be obtained. The trains are composed of a majority of motor-cars, with electric motors and pneumatic control by means of servo-motors. The cars are all controlled from the leading car in this manner.

The generating stations at Servoz and Chavants also possess a very original feature, which consists in the absence of any device to control the flow of water to the turbines. In other words, there are no speed regulators. The turbines drop in speed as the load increases, and the heavy current

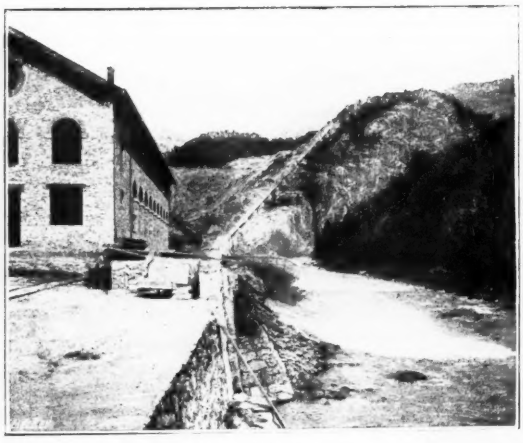


Fig. 8.—Volta Station: Pipe Line and Tail Race.

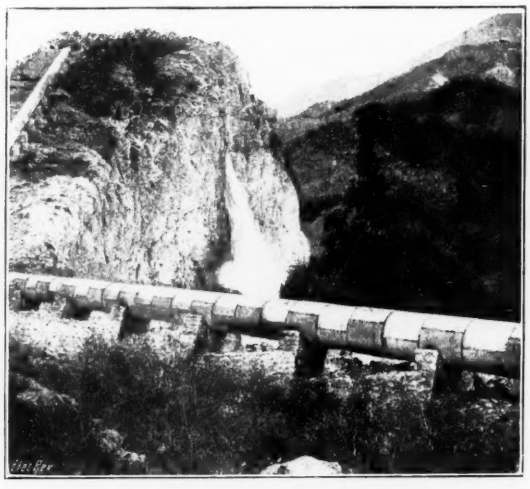


Fig. 9.—Volta Station: Pipe Line and Overflow.

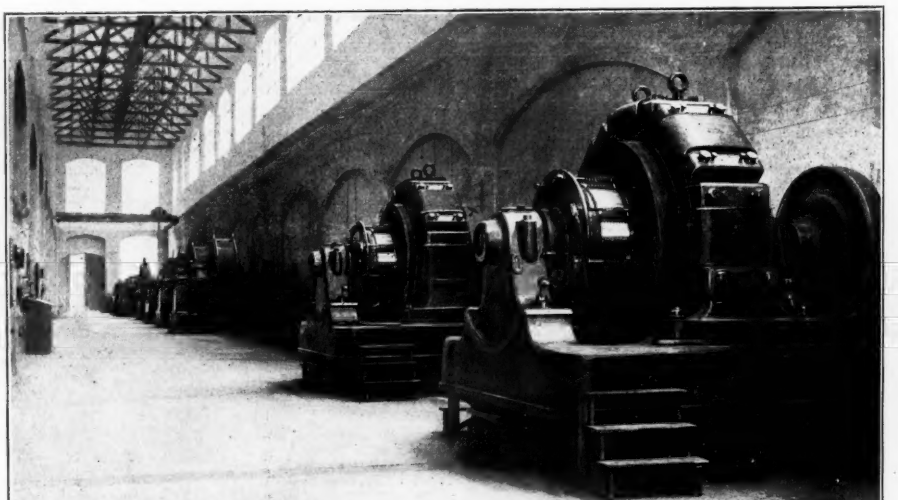


Fig. 10.—Interior of Chedde Station.

which makes the turbine drop in speed is used for compounding the fields of the generators coupled to the water-wheels. The compounding on the line is, by this means, not inferior to that obtaining on any usual railway line. The lamps on the cars are regulated for steady light by means of a kind of moving coil apparatus, controlling a resistance in series with the lamps. This device cuts in or out the necessary regulating resistance steps for keeping the voltage constant. The variation is only about 4 to 5 per cent.

This road, on which a very lucrative tourist traffic has been developed which is continually increasing, will be prolonged into Switzerland. The portion now operated is 19 kilometres long, and works are in progress to remove the existing terminal of Chamonix to the Swiss frontier, where a company is engaged in formulating plans for its extension. Martigny will be the outpost of the Swiss part of the line. This station will be the starting point for the tourist traffic for Mont Blanc, and success is already assured for the line. This Swiss district is a rich industrial centre, and the line will be a great boon to the inhabitants.

Before completing this brief review of the water-power utilisation in France, it may be well to tabulate the actual figures relating to the waterfalls in the Alpine region, and the utilisation thereof :—

Aluminium works	22,536 H.P.
Metallurgical factories	20,485 ,,
Chlorate of potass works	9,000 ,,
Calcium carbide works	104,466 ,,
Sodium chlorates	13,500 ,,
Transmission of power and lighting ...	48,727 ,,
Divers industries	19,989 ,,
	238,703 H.P.

It will be seen that "divers industries" figure for about 20,000 H.P. This power is used in various industries, of which the chief are paper and wood pulp works, cement works, porcelain making, cloth working, saw mills, &c. This large aggregate of power is not, of course, supplied in large quantities, but is distributed over the country in small amounts, varying from 5 H.P. to 2,000 H.P. or so, few works taking the latter amount. The paper pulp works at Albertville uses as much as 2,300 H.P.

The photographs reproduced in this article were taken by M. Michel, of Grenoble, and with the Richard Vérascope, respectively.

LIGHTING AND POWER NOTES.

(*Continued from page* 138.)

Bluff, N.Z.—The official opening of the electric light installation took place on December 3rd, in the presence of the Southland members of Parliament. The function was performed by Sir J. G. Ward, and the Mayor and Mayoress switched on the public and private circuits. The work has been carried out by Messrs. Steuart & Fenn, of Dunedin.

Greenock.—The electrical engineer has been asked by the T.C. to draw up a report on a proposal to supply energy from the Corporation's works to Port Glasgow and Gourock.

The T.C. are about to install another 400-KW. set and certain switchgear at the works.

Hornsey.—The National Electric Wiring Co. has accepted the notice from the B.C. putting an end to its agreement, and waiving the six months' notice.

It has been decided to hold an Electrical Exhibition in the borough on March 1st—4th, stalls to be let to exhibitors of fittings, lamps and appliances.

Tenders are to be obtained for two water-tube boilers, two 300-KW. and one 100-KW. steam generators, and two motor-generators.

Italy.—A concession has been granted to put down a plant at Montemezzo, to utilise the water-power of the River Bugiallo in the generation of electrical energy for power purposes.

Kildare.—An inquiry is to be held on the 25th inst. by the L.G.B. of Ireland into the application of the Naas R.D.C. for sanction to a loan of £3,300 for the purpose of the lighting of the town by electricity.

London.—MARYLEBONE.—The B.C. on the 14th inst. held a special meeting to consider the report of its Electricity Committee on the proposals on the Metropolitan Electric Supply Co., as stated in last week's issue. Mr. E. R. Debenham, chairman of the Committee, moved that the company be informed that the Council cannot accept the proposals. This was carried. It was also stated that it would be necessary that the Bill should be placed before the borough, otherwise they could not get the necessary sanction, and the company were not willing to accept anything except the legalised payment of the debt owing to them. The Mayor issued a letter to 21,000 electors in the borough calling a public meeting for the 19th inst., for the purpose of eliciting the judgment of the electors upon the question.

The Marylebone Ratepayers' Committee distributed a circular, in which, after discussing the various aspects of the question, it recommended the moving of an amendment at the meeting declining to proceed with the Bill, or, alternatively, that a poll of the ratepayers should be taken. The Ratepayers' Committee also issued a short statement in connection with the electric lighting award. The ratepayers were asked to sign a petition urging the Council "to come to some equitable arrangement with the Electric Lighting Co., under which the agreement for compulsory purchase may be cancelled by mutual consent." The secretary of the Metropolitan Electric Supply Co. denies that any definite offer was made to the B.C., the proposals were merely suggestions on the part of the directors.

At the statutory ratepayers' meeting on the 19th inst. the resolution to promote a Bill in Parliament was rejected by an overwhelming majority. The B.C. will, it is expected, consider the question of taking a poll on the matter.

BERMONDSEY.—The Premier Electric Lamp Co. applied to the B.C. a few months ago for a specification and form of tender and enclosed £3 3s. in payment. It subsequently returned the form and stopped payment of the cheque, the company stating that it was under the impression that it was at liberty to quote for lamps only, but as this is not so, it returns the form. The B.C. has resolved to take legal proceedings to recover the amount.

SHOREDITCH.—The B.C. has sanctioned mains extensions to the estimated amount of £200.

WOOLWICH.—The B.C. has resolved to oppose the East London and Lower Thames Electric Power Bill on the ground of unfair competition with the borough supply.

STEPNEY.—On 11th inst. the E.L. Committee and the Finance and Parliamentary Committee of the B.C. reported that they had considered the East London and Lower Thames Electric Power Bill, and recommended that the proposed measure be opposed to the utmost possible extent, and that a petition should be presented in opposition. It was stated that the capital account shows that on December 31st, £189,564 had been expended by the B.C. out of a total authorised expenditure of £314,000, and that, after meeting all expenses, a net profit of £5,145 was obtained during the year ended March 31st, 1903. The average rates at which energy was supplied to private consumers and the public lamps were below those of any other municipal undertaking in the metropolis. During the above period the Council sold 1,759,349 units, of which 1,321,353 units were supplied to private consumers, and 437,996 were utilised for public lighting.

Maidstone.—The T.C. has resolved to wire small houses for electric light at a cost of from £2 15s. to £3 15s. each, and to charge the occupiers an extra ½d. per unit.

Neath.—The R.D.C. has resolved to make application to the L.G.B. for sanction to borrow £20,000 for electric lighting.

New Quay.—The U.D.C., after considering the representations from the Southern Counties Electricity Corporation, has decided to eliminate from the agreement with the company, the whole question of the maximum demand system. The Council had previously fixed similar rates for the maximum demand and flat systems, and the company intimated that it could not possibly consent to such terms.

North Wales Electric Power Scheme.—Sir R. H. Williams-Bulkeley, Bart., has presented a petition stating that as he did not receive the usual notice from the syndicate as to its intentions to apply for power to build a dam across the Afon Glaslyn, of which he is the owner, and also of the land at Llyn Llydau, where it is proposed to construct a reservoir, it does not comply with the standing orders.

Ossett.—The B. of T. has informed the T.C. that it will grant a further extension of time in respect of the prov. order for electric lighting.

Penzance.—The Corporation has approved a draft agreement with the Penzance and District Electric Lighting Co. for the supply of electrical energy to the district.

Saffron Walden.—The T.C. has adopted the recommendation of the E.L. Committee that arrangements be made with the Water Undertaking Committee to place the generating station on its premises. The estimated cost of the installation is £8,500, excluding the purchase of additional property.

Sowerby Bridge.—The Halifax T.C., in response to the request of the U.D.C., has made proposals to supply the Council with energy in bulk, or to take over the powers of the U.D.C. and distribute to consumers.

Stafford.—The L.G.B. held an inquiry on 19th inst. into an application by the T.C. for sanction to borrow £6,600 for electric lighting purposes, including the execution of works within the parish of Castle Church, outside the borough. It was stated in support of the application that there was a demand for the electric light in Rowley Park and in Tittington, and that the existing plant at the electric lighting station was unequal to meeting the demand.

Stalybridge.—The T.C. has resolved to present a petition, either jointly with other local authorities or separately, against the Cheshire Electricity and Power Gas Bill. The Crewe T.C. has also decided to oppose this Bill.

Stanley.—The U.D.C. has received a notice from the Yorkshire Electric Power Co. setting forth the prices it proposes to charge for energy, as follows:—Public lighting, 2d. per unit; power, from 1½d. to ½d, and for a mixed supply for public lighting, small motors, and private lighting about 1⅜d. per unit.

Sunbury.—The U.D.C. has sealed the agreement with Messrs. Edmundson's for the electric lighting of its area.

Swansea.—The Corporation are installing Nernst lamps in St. Helen's Road, Brynmor Road, Gorse Lane, Bryn Road, Brynmor Crescent, St. James's Gardens, Brooklands Terrace, Montpelier Terrace, Rosehill, Terrace Road, Clayton Street, Cromwell Street, and Mount Pleasant. Specifications are being prepared for inviting tenders for two years' supply of motors for hiring out.

Tamworth.—The R.D.C. has decided to oppose the application of the Corporation for powers to light the rural district by electricity.

Taunton.—The Assessment Committee has raised the amount of the poor rate assessment at the E.L. works to £3,400. The Electricity Committee will appeal against this if the amount is not reduced to its satisfaction.

Tavistock.—At a ratepayers' meeting it was decided to support the application of the Tavistock and District Electrical Supply Co. for a prov. order for electric lighting.

Thames Ditton.—The U.D.C. has resolved to oppose the application of Edmundson's Electricity Corporation for a prov. order.

The L.U. Tramways Co. has powers to supply energy in a portion of the district.

Tyne Docks.—The Tyne Improvement Commission has decided to appoint an electrical superintendent to take charge of the lighting of the Docks and start at a salary of £150.

Walton.—The Weybridge U.D.C. has decided not to assent to the application of the Urban Electric Supply Co. for a prov. order for the lighting of its area.

Whitehead.—Arrangements were entered into a few months ago with the National Electric Wiring Co. for the electric lighting of the district. A company was formed, but as applications for shares were very limited, the directors have decided to abandon the scheme.

Willesden.—The U.D.C. has determined to seal an agreement to sell its generating station at a profit of 5 per cent. on the cost to the North Metropolitan Electric Power Supply Co., which will also defray the Council's first three years' loss, and will supply power from the station to the Middlesex C C. tramways. The company also agrees to supply Willesden in bulk at a low rate. Some members of the Council opposed on the grounds that the British Electric Traction Co. was the real company buying, that the station should be retained by the Council, and that the price was inadequate.

Windsor.—The T.C. on January 13th considered at great length tenders for the public lighting of the town by electricity and gas. The Lighting Committee recommended the acceptance of the Windsor and Eton Electrical Installation Co. for 10 arcs of 2,000 C.P. each, 21 arcs of 500 C.P., and 260 lamps of 32 C.P., for £1,375 per annum. The Gas Co.'s tender worked out at £1,156 4s. The matter was eventually referred back for tenders for a more equable distribution of electric light.

Winsford.—The U.D.C. has instructed the clerk to make inquiries with reference to the disposal of the prov. order for electric lighting to a private company.

York.—On 15th inst. the first set of four provided in the extensions entered upon last June, started working. This set is of 1,000 I.H.P.; two others of 1,000 I.H.P. each, and one of 2,000 I.H.P. are provided for.

TRAMWAY AND RAILWAY NOTES.

Birmingham.—Considerable local ill-feeling has been expressed both in the Press and outside by the failure of Aston Manor to give a through service between Birmingham and the Aston districts converging on the Aston Road. Aston delayed commencing the electrification at the request of the shopkeepers on the main thoroughfare, who wished nothing done before the Xmas holidays. The consequence is, that the Aston steam trams are not allowed inside the Birmingham boundary, and through passengers have to change cars, with a walk of about 100 yards thrown in, in addition to paying 3d. for what was originally 2d., though the Birmingham authorities have commenced issuing return fares at 1½d. to the boundary. This concession makes the through fare 2¾d. It is expected the Aston Corporation system will not be ready till the beginning of March.

Charing Cross, Euston and Hampstead Railway.—Work on this railway has so far progressed that the tunnels being driven from opposite the Hampstead Town Hall and from the corner of Adelaide Road have joined. The tunnels have also gone some distance down the Chalk Farm Road at one point, and have nearly reached the junction of Pilgrim's Lane and Rosslyn Hill at the other, so that an appreciable portion of the work has been carried through. So far as the Hampstead High Street works are concerned, they are at present confined to the sinking of the elevator shafts, and just now no tunnelling work is going on from this point.

Chatham.—Our local correspondent says:—"Messrs. West Bros., builders, of Rochester, contracted to build the electric power station and car-sheds of the Chatham and District Light Railways Co. for the British Thomson-Houston Co. A dispute had arisen in regard to an alleged delay on the part of the contractors, with the result that Messrs. West took action in the High Court to recover the balance due on their contract. This brought out an action by the British Thomson-Houston Co. against the builders for damages for delay. The builders seem to have come off victorious in both matters."

Clydebank.—At a meeting of the T.C. it was stated that the work of extending the Glasgow Corporation tramways from Clydebank to Dalmuir would be commenced in April.

Coatbridge.—The tramway company expects to open the new electric tram-line between Coatbridge and Airdrie for traffic in the first week of February.

Dewsbury.—From local correspondents we learn that last Saturday an electric car left the metals, the brake failing to act. The car went through a wall 8 ft. high into a garden. The driver and a number of passengers were injured.

Another version of the affair says that as "soon as the car had been brought back to the rails, and before any part of the mechanism had been touched, a test was made of the working of the Westinghouse magnetic brake, to the failure of which the accident was at first attributed. Despite the facts that the controller was dislocated and the front platform of the car badly broken up, the brake acted perfectly."

Exeter.—Sir Colin Scott-Moncreiff has given his award in the arbitration he has held to decide the amount which the City Council shall pay the Tramways Purchase Syndicate for the existing horse trams which the Corporation will electrify, and include in the scheme of overhead trolley trams for which it has powers to construct. The amount asked by the syndicate was, roughly, £14,900 and the amount offered by the Corporation was, in round figures, £4,900. The amount awarded by the arbitrator is £6,749—an amount which the Corporation on Wednesday evening considered highly satisfactory. The arbitrator decides that the parties shall pay their own costs, the Corporation to pay the arbitrator's fee, £101. It is now proposed to proceed without delay to the construction of such portions of the new tramways as do not involve street widening.

Greenock.—The burgh electrical engineer has reported to the T C. that the plant originally installed to supply the tramway company with traction was insufficient on several occasions during the past month, and the supply had to be supplemented from the lighting plant. In terms of the lease the company had the right to call upon the Corporation to provide more plant, but had not done so yet. The engineer was instructed to interview the tramway company's representative and report.

Huddersfield.—The Tramways Committee, having received an intimation that it is proposed to construct a tramway between Halifax and Huddersfield, *viâ* West Vale and Elland or Brighouse, has instructed the town clerk to state that the Corporation welcomed the proposal, and had no objection to the line joining the Huddersfield tramways at their terminus.

Leyton.—A town's meeting has approved of a proposal by the U.D.C. to promote a Bill in Parliament to construct tramways at a cost of £152,000.

Liverpool.—The annual traffic returns of the tramways for the year which ended on December 31st last, have been issued. The following are the principal figures:—

	Mileage.	Passengers.	Receipts.	Inc. in traffic receipts.
1897	6,013,180	38,409,084	£290,743	—
1898	6,279,758	41,772,034	£314,207	£23,464
1899	7,600,546	63,771,450	£359,929	£45,722
1900	9,100,866	82,367,958	£417,574	£57,645
1901	10,970,069	101,108,780	£468,383	£50,809
1902	11,790,815	109,385,585	£506,626	£38,243
1903	11,734,838	113,057,234	£524,509	£17,883

The increases in the past year over 1902 have been as follows:—Passengers, 3·40 per cent.; receipts, 3·53 per cent. Compared with 1897, the last year in which the old company had control, the increase last year was:—Passengers, 194·35 per cent.; mileage, 95·15; and receipts, 80·40 per cent. The increase in the receipts and the number of passengers carried in 1903, compared with 1902, was effected with a diminution in the mileage, of 55,977 miles.

Paris Underground Railway.—We read in the *Times* that the officials of the Paris Metropolitan Railway have decided to abandon the use of power cables carrying large high-pressure currents through the train, and have awarded a contract to the French Westinghouse Co. for the supply of 100 complete equipments of their electro-pneumatic turret-type control apparatus to take the place of the present system.

Perth.—Messrs. Kincaid, Waller, Manville and Dawson have been appointed by the T.C. consulting engineers in connection with the conversion of the Corporation tramways from horse haulage to electric traction.

Yarmouth.—In view of the Corporation obtaining the transfer of the Gorleston tramways shortly, and adopting electrical working, the Committee has recommended the adoption of the borough surveyor's report for carrying an electric cable across the river. In the opinion of the borough surveyor and its consulting engineers, the overhead method should be adopted. The Port and Haven Commissioners have resolved that the height of the steel masts which will be used should not be less than 150 ft. above high-water.

TELEGRAPH AND TELEPHONE NOTES.

Bournemouth Telephones.—The Telephones Committee has had under consideration a draft agreement, sent by Mr. F. F. Bennett's solicitors, under which the International Electric Co. would be prepared to construct a telephone exchange in Bournemouth. The Committee resolved to meet Mr. Bennett to discuss the question.

The Guernsey Cable.—The *Pall Mall Gazette* for 13th inst. states:—"Telegraphic communication between England and the Channel Islands has been suspended for over a week by reason of the breaking of the cable a few miles off the coast of Guernsey. We now learn that the cable ship *Dacia*, which was sent out to repair the damage, has been obliged to put into Cherbourg Harbour, and the work cannot be carried on while the present heavy weather lasts. Meanwhile, telegraphic communication with England has to be made through France, and much inconvenience is consequently experienced."

Russian Posts and Telegraphs.—According to the most recent statistics, the number of the Russian post and telegraph stations was 4,861 at the end of 1901. Of that number, 1,983 (40·8 per cent.) were merely post offices, 355 (7·3 per cent.) telegraph offices, and 2,523 (51·9 per cent.) were combined post and telegraph offices. Compared with 1901, the number has increased by 80 offices. Besides, in 1901, 353 railway stations were provided with post and telegraph stations. The number of railway stations with post offices is 4,221. Moreover, post offices were opened in 1,885 local administrations. Therefore, the total number of places with post offices amounts to 10,967. The number of telegraph stations was 2,878. The telegraph lines had a length of 140,322 wersts. The length of the wires was 320,486 wersts. In comparison with the preceding year, the number of lines increased by 2,839, and the wires by 10,453 wersts. The number of telegraph stations in operation was 5,714, and these contained, among others, 252 Hughes and 28 Wheatstone instruments for fast speed telegraphy. There were 103 telephone plants, of which 91 belong to the Government and 12 to private undertakers. The total length of the telephone conductors was 70,031 wersts. The number of subscribers was about 40,000, which means an increase of 24 per cent. in comparison with 1900. That large increase is in consequence of the reduced taxes on the old lines of the Bell Co. The telephone line from Petersburg—Moscow, was used by 592 subscribers. In 1901, the net proceeds of that line amounted to 60,032 roubles, which means 15 per cent. interest for the costs of construction. In 1901 the telegraph conveyed altogether 19,703,327 telegrams, of which 16,779,280 were inland and 2,923,507 were international ones. In comparison with 1,900, the increase is 1·6 per cent. as to inland and 5·8 per cent. as to international telegrams.

Telegraph Cable Imports.—The value of the foreign telegraph cables and apparatus connected therewith imported into this country during December last amounted to £1,379, bringing up the total for the whole of 1903 to £57,360.

Telegraphic Interruptions and Repairs:—

CABLES.	INTERRUPTED.	REPAIRED.
Dominica-Martinique	May 5, 1902	
St. Lucia-Martinique	May 7, 1902	
St. Lucia-St. Vincent	Sept. 19, 1902	
Trinidad-Demerara No. 1	Aug. 27, 1901	
St. Kitts-Antigua	Jan. 8, 1904	
St. Vincent-Grenada	Dec. 28, 1903	Jan. 14, 1904
Mole St. Nicolas-Port-au-Prince	Dec. 16, 1903	
Cayenne-Pinheiro	Aug. 18, 1902	
Paramaribo-Cayenne	Feb. 26, 1903	
New York-Hayti	April 18, 1903	
Anjer-Kalianda	Aug. 2, 1902	
Reissa-Issa (Yemen)-Camaran	Oct. 22, 1902	
Tourane-Amoy	Nov. 10, 1903	
Perim-Obok	Jan. 14, 1904	Jan. 16, 1904
Gibraltar-Tangier	Jan. 16, 1904	Jan. 19, 1904
Tarifa-Tangier	Jan. 18, 1904	
SIBERIAN LANDLINES.		
Kertch-Soukhoum Kale	Jan. 18, 1904	Jan. 19, 1904

Underground Telegraphs.—Last year the Postmaster-General gave effect to one of his promises *re* underground telegraphs by the laying of an experimental cable between Birmingham and Warrington, and this cable was in use till May, 1903. Since that date, says the *Times*, gangs of men have been engaged in taking out the experimental wires and putting in a main permanent cable between the Midlands and Lancashire. The cable, which is laid in a 3-in. cast-iron pipe, contains 103 wires, enclosed in a leaden sheathing; 74 of the wires are twisted in pairs, and the remainder are single wires. The pairs of wires may be used for telephonic purposes, but it is believed that their primary use will be for high-speed telegraph circuits. The route from Birmingham is *vid* Walsall, Cannock, Stafford, Eccleshall, Woore, and Nantwich. At the present time the cable has been completed to Eccleshall. It is hoped to have the cable completed to Warrington before the end of next March. At Warrington lines connecting Liverpool and Manchester can be tapped. It will then be possible to work from London to those cities by means of underground wires. During the Department's next financial year, probably the section between Warrington and Carlisle will have attention. A line is also being laid north-east from Manchester to serve the large Yorkshire towns.

Wireless Telegraphy.—We learn from the *Elettricista* that the Italian Legation at Peking has recently been provided with a wireless telegraphy station, which enables the legation to communicate directly with the Italian war vessels moored either at Takou or Tientsin, or even those that cruise along the north side of the Chinese Sea without having recourse to the Chinese lines.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—January 22nd. Motor-balancer and motor-boosters. See "Official Notices" January 8th.

Bristol.—The Corporation is anxious to receive from manufacturers, particulars of their standard single-phase H.T., and three-phase E.H.T. switch-gear. See "Official Notices" to-day.

Canterbury.—February 8th. Four motor-driven pumps. See "Official Notices" to-day.

Chili.—June 28th. Tenders are being invited for the public electric lighting of the city of Punta Arenas (Straits of Magellan), which will be opened on June 28th next, at 2 p.m., in the offices of the Municipal Commissioners of that city. Full particulars can be obtained on application to the Chilian Legation, 29, Queen's Gate Terrace, S.W.

Edinburgh.—February 22nd. Engine and dynamo of large size. See "Official Notices" to-day.

Hastings.—January 30th. Supply of alternating current motors on hire-purchase agreement. See "Official Notices" to-day.

Hornsey.—February 8th. Two dryback boilers, smoke consuming apparatus, 100 and 300-KW. steam dynamos, motor-generators. See "Official Notices" January 8th.

Islington.—February 24th. Conduits and mains. See "Official Notices" to-day.

Kirkcaldy.—February 1st. Seven motor-cars for the Corporation. See "Official Notices" to-day.

L.C.C.—February 2nd. Tenders are being invited for roadwork and platelaying for the electrifying of certain tramways in South London. Particulars, &c, at the Engineer's Department, L.C.C.

May-Oatway Installations.—The May-Oatway Fire Appliances, Ltd., invites tenders for installations of its system at Govan and Dundee. See "Official Notices" to-day.

Mexico.—The Municipal Authorities of Culiacan (Sinaloa) are at present inviting tenders for the concession for the establishment and working during a period of 5 years, of a central electric lighting station in the town.

Rochdale.—January 30th. Electric lighting alterations at the Workhouse. See "Official Notices" January 15th.

South Shields.—March 12th. The Corporation invites offers for the lease of certain tramways. See "Official Notices" January 15th.

Spain.—February 12th. Concession for an electric tramway between Porrino and Mondariz (Pontevedra province). See "Contracts Open" December 18th.

Spain.—February 15th. The Public Harbour authorities at Barcelona are inviting tenders until February 15th for the contract for the establishment of the plant and equipment for the electric lighting of the sheds at the Port of Barcelonnette, and for the operation of the cranes, travellers, &c.

West Ham.—February 11th. Stores, cable, recording wattmeters, cut-out boxes, transformers, incandescent lamps, and coal for the electricity department. See "Official Notices" to-day.

Whitby.—January 25th. Cables for the electricity department. See "Official Notices" January 8th.

CLOSED.

Admiralty.—The Admiralty has renewed the contract for the supply of "Dejecoline" boiler scale removing fluid for his Majesty's Dockyards, during the ensuing 12 months with the British Boiler Fluid & Engineers' Stores Co., Ltd., of Limehouse. This is the fourth year in succession that the company has obtained the Admiralty contract.

Bermondsey.—The B.C. received the following tenders for two water-tube boilers, overhead flue, coal-bunkers and coal-handling plant, and extensions to steam, feed and exhaust pipes :—

The Stirling Boiler Co. (including economisers)	£8,018
Babcock & Wilcox, Ltd. (without economisers)	7,600
" " " (including economisers) accepted ..	7,990
Graham, Morton & Co., Ltd. (tender incomplete)	1,869

Blackpool.—The Corporation has ordered from the British Westinghouse Co. a steam electric set, comprising a Browett-Lindley three-crank, three-cylinder triple-expansion engine, driving a 450-KW. Westinghouse dynamo. The latter machine will be horizontally divided, and will be so compounded as to give 500 volts at no load, and 530 to 550 at full load, running at 330 r.p.m.

Cardiff.—Messrs. Geo. F. Milnes & Co., Ltd., of Hadley, have received an order for 15 combination single-deck car-bodies for the Corporation. They have also recently received orders for four double-deck car-bodies and trucks for the Lowestoft Corporation, and six double-deck car-bodies for the Wolverhampton Corporation.

Coventry.—The E.L. Committee has decided to place an order with Messrs. J. & H. MacLaren for an additional 1,000-H.P. engine, similar to the one recently supplied, at a cost of £4,169, and with the British Schuckert Electric Co., for an additional 600-KW. two-phase alternator, also similar to the one recently supplied, at the price of £1,150.

France.—The French Post and Telegraph Authorities in Paris have just placed contracts as follows:—La Compagnie Française des Metaux, Paris, 30 tons of bronze wire, 1½ mm. diameter at 2,510 fr. per ton, and 150 tons ditto, 3 mm. diameter at 1,930 fr.; La Compagnie Générale d'Electricité, Paris, 50 tons ditto, 1½ mm. diameter, at 2,529 fr., and 100 tons 4 mm. diameter at 1,910 fr; Les Mines et Fonderies de Pontgibaud, 50 tons ditto, 2½ mm. diameter, at 1,907½ fr.; La Compagnie Française du Bimetal, Paris, 50 tons ditto, 2½ mm. diameter, at 1,910 fr, and 50 tons, 2 mm. diameter, at 1,689 fr.; La Société d'Electro-Metallurgique de Dives, 150 tons ditto, 3 mm. diameter, at 1,895 fr.; La Compagnie des Trefileries du Havre, 150 tons ditto, 3 mm. diameter, at 1,908 fr., 100 tons ditto, 4 mm. diameter, at 1,902½ fr., and 100 tons ditto, at 1,908 fr.; M. Grammont, Pont de Cheruy, 200 tons ditto, 4 mm. diameter, at 1,905 fr.; and Les Forges de Franche Comté, Besançon, 100 tons ditto, 4 mm. diameter, at 1,904 fr.

Kingston.—The T.C. has placed an order with Messrs. Siemens Bros. for a 200-KW. generator, with spare fittings, &c., for £2,112 15s.

Lowestoft.—On January 12th the T.C. accepted the tender of Messrs. G. C. Milnes, Voss & Co. for a car-pit bogey at £37 10s., and that of Messrs. Selig, Sonnenthal & Co., for a lathe for turning car wheels at £77.

Todmorden.—The T.C. has accepted the following tenders for plant for the E.L. works:—

Messrs. Yates & Thom, boilers.
Messrs. Green & Son, economiser.
Electric Power Storage Co., Ltd., battery.
Worthington Pumping Co., Ltd., condenser, pumps and ejectors.
B. Thomas, switchboard.
W. T. Glover & Co., Ltd., cables.
Bruce Peebles & Co., Ltd., steam dynamo and engine.
Rodgers & Kay, crane.

Walsall.—The T.C. has placed with the Leeds Steel Co. an order for 100 tons of tram rails for repairs, &c.

FORTHCOMING EVENTS.

Friday, January 22nd.—At 8 p.m. Physical Society. Meeting at the Royal College of Science. "The Photographic Action of Radium Rays," by Mr. S. Skinner. Exhibition of Instruments, by Messrs. Crompton & Co.

At 8 p.m. Junior Institution of Engineers. Presidential address by Mr. J. Fletcher Moulton, K.C., F.R.S.

At 7.30 p.m. North-East Coast Institution of Engineers and Shipbuilders. Resumed discussion on Mr. Max Wurl's paper on "Technical Education in Germany."

Saturday, January 23rd.—At 7.30 p.m. Glasgow Technical College Scientific Society. "Some Observations on Mechanical Training, by Mr. W. D. Hamilton.

At 10.15 a.m. Institution of Electrical Engineers. Students' visit to India-Rubber, Gutta-Percha and Telegraph Works Co.'s works.

Tuesday and Wednesday, January 26th and 27th.—At Institution of Civil Engineers, Gt. George Street, S.W. Engineering Standards Committee—Electrical Conference. (See page 135 of this week's issue.)

Wednesday, January 27th.—At 8.30 p.m. Unveiling of the tablet erected to the memory of the Electrical Volunteers who died in South Africa during the war.

At 7.30 p.m. Institution of Electrical Engineers (Birmingham). Mr. C. A. Smith on "Energy Distribution to Sub-stations," and short demonstration on "Some Uses of the Oscillograph," by Dr. D. K. Morris and Mr. J. K. Catterson-Smith. Visit to West Bromwich Electricity Works will precede meeting.

At 8 p.m. Liverpool Engineering Society. Prof. E. W. Marchant on "Induction Motors."

Thursday, January 28th.—At 8.0 p.m. Institution of Electrical Engineers. Adjourned discussion on "The Edison Accumulator for Automobiles," by Mr. W. Hibbert, and "On the Magnetic Dispersion in Induction Motors, and its Influence on the Design of these Machines," by Dr. Hans Behn-Eschenburg.

At 8.30 p.m. Tramways and Light Railways Association. Meeting at the Society of Arts, Mr. R. Hammond in the chair. "Rating of Tramway and Light Railway Undertakings," by Mr. W. G. Bond, member.

Friday, January 29th.—At 8 p.m. Institution of Civil Engineer (Students). "Metallurgy as Applied in Engineering," by Mr. A. P. Head.

Saturday, January 30th.—At 8 p.m. Bohemian concert of the Electrical Engineers R.E. Vols., at headquarters, Regency Street, S.W.

NOTES.

Bristol Fire.—Mr. H. W. Clothier has requested us to say that the full text of his paper may be obtained by anyone wishing to take part in the discussion thereon, on application to him at the following address:—108, Gilda Brook Road, Eccles.

Motor-car Weights.—It is announced that the President of the Local Government Board has appointed a Departmental Committee to inquire and report with regard to any regulations which should be made under Section 6 of the Locomotives on Highways Act, 1896, and Section 12 of the Motor-car Act, 1903, as respects any class of vehicle for the purpose of increasing the *maximum* weights of 3 tons and 4 tons mentioned in Section 1 of the former Act, and with regard to any conditions as to the use and construction of the vehicles which should be made by any such regulations. The members of the Committee are the Right Hon. Henry Hobhouse, M.P. (chairman), Sir William Arrol, M.P., Mr. H. C. Monro, C.B., Mr. H. H. Law, M.Inst.C.E., Mr. George Deacon, M.Inst.C.E., and Mr. H. Graham Harris, M.Inst.C.E. Mr. R. J. Simpson, of the Local Government Board, will act as secretary to the Committee.

Horses Electrocuted.—It is reported that on Monday three horses which were hauling a heavy load of iron up Castle Hill, Dudley, were killed by electric shock. It seems that a defective insulator had led to one of the trolley poles erected in the middle of the road, becoming "alive," and one of the horses swerved against this, with the result that all three of the horses fell dead instantaneously. The driver had guided them on to the metals for a better foothold.

British v. Foreign Steel Making.—It is stated by a financial contemporary that one of the largest steel making firms in the Midlands, which has hitherto been buying German steel billets, has now decided to produce all its own requirements. Some time ago the firm abandoned the manufacture of steel, and last year bought 50,000 tons of German material at 10s. per ton less than it could produce it at. Now it has had its furnaces relined and improved its plant, with the object of more economical production. The firm owns ore mines, and is the largest consumer of steel in the Midlands.

The Fulham Baths Accident: Sequel.—The Legal Committee of the Fulham B.C. reported on Monday that since the settlement of the claims of the relations of the unfortunate victims of the electric light accident at the Fulham Baths in December, 1902, the town clerk had been in communication from time to time with the solicitors of the National Electric Wiring Co. with respect to the damages, costs, and expenses paid by the Council in respect of the accident. The solicitors, on behalf of their clients, denied liability. The Committee resolved that the necessary action be taken to enforce the Council's claim against the company.

Electricity in Germany.—Last month the *E.T.Z.* published its annual statistics relating to the electricity supply industry up to the end of March, 1903. According to these data, there were no fewer than 939 electricity works, having generating plant of nearly 400,000 KW. installed. From this it will be seen that the average size of the stations listed is very small—in fact, about 425 KW. In this country, on the other hand, there are only about one-third as many stations, but they are on the average more than three times as large. Nearly 500 of the German stations are of less than 100-KW. capacity. It is interesting to notice that in Germany, in addition to the generating capacity above mentioned, there is storage plant equivalent to nearly one-fourth of the capacity of the generating plant; and in estimating the *output* capacity, this should be taken into account.

More than 81 per cent. of the stations are pure direct-current stations, and almost all of these have storage; their total capacity, however, is only 250,000 KW., so that the A.C. stations are clearly much the larger. It is difficult to estimate precisely the relative sizes of the D.C. and A.C. works, as out of the 173 which are not wholly D.C., no fewer than 67 supply both D.C. and A.C., having a total generating capacity of 90,000 KW.

There are 43 stations having generating plant of more than 2,000 KW., and of these 17 are above 5,000. The largest works are in Berlin, viz., Moabit and Oberspree, of more than 25,000 KW. each. The only large water-power station in Germany is Rheinfelden, having 12,000 KW. The glow lamps connected, reduced to 33 watts each, number nearly 7¾ millions, and the motors 219,000 H.P., including traction motors. During the last three years the aggregate of the consuming devices connected has practically doubled. In Berlin alone the connection is equivalent to nearly 2 million 8-C.P. lamps.

Fire at Salford Electricity Works.—A fire, which completely disorganised the lighting and tramways service for a time, broke out at the Salford Electricity Works at 8 a.m. on Sunday, the 17th inst. Mr. Taite, the borough electrical engineer, courteously granted our correspondent an interview, from which the following particulars were obtained:—It is impossible to ascertain the exact cause of the fire, but it is surmised that the fracture of a shunt wire set up an arc which fired the insulation on one of the mains. The dynamos are connected to the lighting and traction boards through change-over switches, and all the cables between the first four machines and the boards were totally destroyed, together with the switches themselves. Several panels of the traction board were cracked and otherwise damaged, and most of the instruments and shunts were incapacitated. The feeder connections to the switchboards terminate in kicking coils beneath the switchroom, and these feeders were unaffected by the fire. The lighting and power board, although intact, could not be used until the change-over switches, as mentioned above, had been disconnected. This was accomplished by 12.45 p.m. on Sunday, when the whole system was again supplied. The re-wiring of the traction board was completed shortly before 4 a.m. on Monday, in time to run the earliest cars. A service had been maintained on Sunday afternoon and evening by means of current taken from Manchester. Much interest was evinced by the public in the bonding over of the breaks in the overhead equipment at the various points where the systems join. The floor of the switchroom is made of steel joists and concrete covered with wood blocks—these latter did not take fire, nor was the structure in anyway damaged. The cost of the fire is estimated at from £1,200 to £1,500, which would probably have been considerably exceeded but for the promptitude of the Fire Brigade, which arrived within four minutes of receiving the call.

We understand that after the fire an order was immediately given to Messrs. W. T. Glover & Co., Ltd., for their patent fire-resisting cable to replace the ordinary rubber cable, which had been damaged by the fire.

Central London Railway.—In a paper read by D. P. Thompson, before the Rugby Engineering Society, last month, compiled largely from an article in *Traction and Transmission*, written by Mr. H. F. Parshall, consulting engineer to the Central London Railway, it is stated that by virtue of the gradients from the stations gravity gives about 33 per cent. of the torque at starting, while 66 per cent. is furnished by the power station. This decreases the amount of power, taken over the whole cycle of operations of starting, accelerating, and braking, by about 25 per cent. The rate of acceleration is about 1 mile per hour per second; viz., in order to get up to 26 miles an hour maximum requires 26 seconds. The braking is about 1½ miles to 2 miles per hour per second. The amount of power required to drive a train over an average section depends to a large degree on the length of the section. Considering an average section which is level, 1,800 ft. requires about 150 to 175 KW. per train; while on a 3,600 ft. section only 100 KW. per train would be required, the speed maintained being an average of 14 miles an hour. If it were possible to combine three sets of stations of two each, beginning at the Bank end in one direction and leaving off at Marble Arch, while beginning at Shepherd's Bush at the other end and leaving off at Bond Street, the speed would be increased about 12 per cent. without taking any more power. Thus, in order to get high speeds we must have few stations, or run two independent sets of tracks, one for the local traffic, and the other for the express. The generating plant runs 20 hours each day and delivers an average of 44,000 KW.-hours, which gives an average of 2,200 KW. During the peaks of the load, which occur during the three hours of the morning and evening, a load close on 4,000 KW. is sustained. The rotaries are generally placed in pairs at a sub-station, the rating of each machine being 900 KW. They are however, able to deliver peaks of load of 2,700 KW. each, *i.e.*, one rotary is capable of taking care of the peaks of a load during the three hours morning and evening of the heaviest duty. These machines are subjected to short-circuits on the third rail and capable of standing three times their normal load. There is a maximum peak load from the generating station of 3,400 KW., and a corresponding output from all the sub-stations of 3,050 KW. In an all-day average load the generating station produces 2,280 KW., and this converts into 2,000 on all the substations. The following table represents the distribution on a peak load and on an all-day load taken from Mr. Parshall's figures:—

	Peak load.	All day.
Third-rail feeders	2,350	1,500
Lift feeders	360	235
Lighting feeders	300	255
Power supply depôt	40	30
	3,050	2,020

The cost of power is ·4d. per KW-hour.

Electrical Volunteers' Concert. — On Saturday, January 30th, at 8 p.m., a grand Bohemian Concert will be held at the headquarters of the Electrical Engineers, R.E. Volunteers, Regency Street, S.W., under the presidency of the officer commanding. Tickets (1s. each) can be obtained from any member of the Entertainments Committee, or from the Sergt.-Major, at headquarters.

Northern Polytechnic Institute.—Last night Mr. A. M. Torrance, Mayor of Islington, distributed the prizes gained by students during the 1902—1903 session, at this Holloway Road Institute.

Electrical Engineers' Ball.—A dance on a large scale is projected to take place at the Hotel Cecil on Monday, February 15th. The following gentlemen form the Committee:—

Alabaster, H.	Kingsbury, J. E.
Browett, T.	Madgen, W. L.
Callender, T. O.	McMillan, W. G.
Cushing, Thos.	Mance, Sir Henry C., C.I.E.
De Segundo, E. C.	Massey, W. H.
Dobson, S. T.	Mordey, W. M.
Erskine, R. S.	Nalder, F. H.
Ferranti, S Z. de	Raworth, John S.
Gatehouse, T. E.	Rider, J. H.
Gavey, J.	Roberts, Martin F.
Geipel, W.	Salomons, Sir David, Bart.
Gill, F.	Sharp, Sidney
Gray, R. Kaye, Pres. I.E.E.	Siemens, Alex.
Grindle, G.	Sillar, A. M.
Gripper, F. E.	Smith, Fredk.
Hammond, R.	Sutton, G.
Hirst, H.	Verity, G. H.
Kempe, H. R.	Wallis-Jones, R.
Kent, J. V. Money	Webber, Major-Gen., C.B.

EXECUTIVE COMMITTEE:

Kingsbury, J. E.	Roberts, Martin F.
Geipel, W.	Wallis-Jones, R.
Hon. Treasurer:—	*Hon. Secretaries:*—
Hammond, Robert.	Sillar, A. M.
	Alabaster, H.

English Ownership of German Copper Mines.—Some time ago an offer to sell certain large copper-ore mines in Silesia was declined by the English firms to whom it was made, but since then it is said that various mines of medium class in the Moselle and Ahr districts have passed into British possession. The Berlin *Tageblatt* now states that negotiations are proceeding between English merchants and the owners of the copper-ore mines in Westerwald and the Eiffel with a view to the purchase of these mines, which have not been worked for nearly 40 years. As the transport facilities available at the present time are considerably superior to those obtaining in former days, it is thought that the mines could now be profitably worked. The object of the intending purchasers is to obtain supplies of copper so as to be independent of the international market. It is also announced that negotiations have been commenced for the acquisition of copper-ore mines in Saxony.

An Acetylene Element.—It is reported that a Berlin electrical firm has invented a new primary gas battery which depends for its source of energy on the heat of oxidation of acetylene. The "cathode" is a porous hollow cylinder of carbon saturated with a compound of copper, and constantly supplied with a current of acetylene entering through the central channel. The "anode" is some indifferent material such as carbon, platinum, or some substance carrying a layer of platinum black. The electrolyte is a solution of hæmatin. Atmospheric air is fed into the liquid round the anode, and under the influence of the platinum black re-oxidises the reduced products of the hæmatin. At the cathode, the acetylene combines with the copper to form copper acetylide, which is decomposed by the electrolyte into carbon dioxide, water, and cupric oxide, the hæmatin being reduced to hæmochromogen. The cupric oxide is converted back into copper acetylide by the gas within the cathode. Precise details are at present lacking.

The Impurities of Calcium Carbide.—Some experiments on the derivation and behaviour of the usual impurities (sulphur and phosphorus) in calcium carbide have been carried out lately by H. Gall at the carbide factory at Notre Dame de Briançon, in Savoy. The amount of phosphorus in the raw materials from which the carbide was manufactured was: lime, from 260 to 390 grammes; anthracite, 33 grammes; and electrodes, 310 grammes per metric ton. The finished carbide contained up to 648 grammes of phosphorus per metric ton. On an average the quantity of sulphur in the carbide was 6,600 grammes per ton. When the substance is decomposed in presence of a sufficiently large quantity of water, the whole of the sulphur remains in the solid residue, but the whole of the phosphorus, on the contrary, enters the acetylene which is evolved.

Production of Electric Waves.—At a recent congress held in Cassel, Prof. H. Th. Simon described a novel method allowing of high frequency alternating currents, or electric waves, being produced for use in wireless telegraphy, the underlying principle being analogous to the periodical mechanical phenomena occurring for instance in organ pipes. In the experiments made by the author in conjunction with Mr. Reich, electric arcs passing between metallic electrodes showed all the characteristics of such an arrangement. By means of high-pressure continuous currents the experimenters were able to set up highly efficient electric vibrations by means of metallic spark gaps placed in a vacuum, these vibrations being similar to those produced with the Hewitt mercury lamp and high-pressure alternating currents. The behaviour of high frequency currents is by no means altered under these conditions. The author considers the usual method of producing electric waves by means of spark gaps in air, in connection with induction coils, as being irrational, furnishing relatively irregular high frequency currents. As the working condition of a given high frequency system may in each special case be accurately modified according to the sparking distance, the method suggested by Prof. Simon seems to be well-adapted for wireless telegraph purposes.

Obituary.—G. F. TRAIN.—The death is announced from New York of Mr. G. F. Train, who, it is said, laid the first tramway in this country in 1860. Mr. J. Clifton Robinson, of the London United Tramways Co., was then a boy on his staff. In 1866 the latter accompanied Mr. Train to America, and obtained important experience in transportation matters.

Admiral of the Fleet Sir Henry Keppel, G.C.B., died on Sunday afternoon in London at the advanced age of 94. Sir Henry was a director of the Direct United States Cable Co., Ltd.

Appointments Vacant.—Assistant station engineer (£160), shift engineer (45s.), switchboard attendants (35s.), overhead work foreman (50s.), motor instructors (45s.), motor inspectors and various other members of staff for the Leicester Corporation tramways; electrical fitter and engineer for the Camberwell Infirmary (25s. +); assistant lecturer and senior demonstrator in Electrical Engineering for Salford Royal Technical Institute (£130); electrical superintendent for the Tyne Improvement Commission (£150).

Personal.—On 11th inst. the employés of the Poole and District Electric Traction Co. held their annual conversazione. During the evening the staff presented to Mr. E. H. Mottram, the manager of the company, and his wife, a silver spirit stand and kettle, as a mark of esteem.

Sheffield T.C. has appointed Mr. Alfred Handford, of Salford, as tramway claims superintendent, at an annual salary of £220, and Mr. Alan Harrison Day, as assistant claims superintendent, at a salary of £104 per annum.

The Bournemouth Council has increased the salary of Mr. C. Barker, the tramways traffic manager, from £250 to £300.

The Birkenhead Tramways Committee has selected Mr. Wyld, of Doncaster, for the position of manager of the electric tramways (£450).

We are very pleased to learn that Mr. W. E. Lane has pretty well recovered from the effects of his recent nasty experience. He was in Court on Wednesday giving evidence in the prosecution of his assailant.

Testing Cables under Pressure.—A circular which has come to hand describes the method of testing lead-sheathed cables under a hydraulic pressure of 100 lbs. per sq. in., which has been "patented" by Messrs. W. T. Glover & Co. It is of interest to note that this method has been in use for 25 years at the works of Messrs. Siemens Bros. for testing gutta-percha core for submarine cables—but at a pressure of no less than 3 tons per sq. in.!

The Marylebone Mess.—Since the article on our leader page went to press, we learn that the Marylebone Council has under consideration offers which have been received from the General Electric Co. and the Westinghouse Co. respecting the new plant required and respecting the working of the undertaking generally when taken over. Mr. Debenham, chairman of the Electric Supply Committee, favours the adoption of the General Electric proposal. A meeting of the Council was to be held last night to decide what steps should be taken in view of the result of the ratepayers' meeting.

THE CENTRAL STATION ENGINEER.

MR. R. J. WILTON, who was the first manager of the Southport Corporation electric tramways, and who some time ago left Southport to take up a position in Manchester, has accepted the appointment of electrical engineer to the Calcutta tramways. He sails on 30th inst.

Mr. T. H. KINGDON, electrical engineer, who has been attached to Chatham Dockyard for some time past, has entered upon his duties as electrical engineer at Sheerness.

Out of 48 applications for the post of electrical engineer to Boston T.C., Mr. GEO. E. CLARK, of Sheffield, and Mr. W. J. WHITE, of Cheltenham, have been selected to appear before the Council. The salary is £300 per year.

Aston T.C. has made the following electrical appointments:—Mr. R. B. LEACH, of Sheffield electricity works, as meter superintendent and mains inspector; Mr. F. W. PARSONS, of Northwich, as switchboard attendant; and Mr. A. G. TURNER, of Watford, as chief clerk.

Newcastle-on-Tyne T.C. has increased the salary of Mr. A. E. Le ROSSIGNOL, tramways manager, from £750 to £850 a year, with annual increments to £1,000.

Sunderland T.C. has appointed Mr. L. E. HARVEY, of Halifax, as assistant tramways engineer, at an annual salary of £200, rising to £250.

Mr. T. ROBERT SMITH, A.M.I.E.E., chief electrical and mechanical assistant to the borough engineer of Leicester, has been unanimously appointed by the Tramways Committee of the Corporation of Leicester the resident electrical engineer for their tramways, to take charge of the working and general repairs and maintenance of all completed electrical plant and equipment of the power station, car depôts, overhead work, cars, and feeder system, at a salary of £250, rising to £350 per annum. There were 129 applicants for this appointment, five of whom were selected and attended before the Committee. Mr. E. GEORGE MAWBEY, M.I.C.E., is the engineer-in-chief, and Mr. E. MANVILLE, M.I.E.E., is the consulting engineer for the electric tramways of the borough.

The Maidenhead T.C. has increased the salary of its resident engineer, Mr. MILTON, from £150 to £180.

The Maidstone T.C. has appointed Mr. E. E. HOADLEY, resident electrical engineer, as manager of the electric tramway undertaking for one year, his salary being increased by £50.

NEW COMPANIES REGISTERED.

Electrograph, Ltd. (79,649).—This company was registered on January 4th, with a capital of £10,000 in £1 shares, to acquire the interest of E. G. Craven in an invention known as "Electrograph," to acquire patents, concessions or other privileges relating thereto, and to carry on the business of manufacturers of, and dealers in, "electrographs," and electrical instruments or apparatus of any kind, electrical and mechanical engineers, electricians, machinists, fitters, founders, smiths, wire drawers, &c. The first subscribers (each with one share) are:—E. G. Craven, 1A, Greville Place, Maida Vale, N.W., engineer; C. W. Forward, 6, Blackfriars Road, S.E., bookbinder; H. V. Stow, "Holmstead," Lovelace Gardens, Surbiton, secretary; W. B. Brewster, 21, Holborn, E.C., secretary; J. A. Carver, Gresham Life Assurance Co., Poultry, E.C., house steward; G. C. Harrower, College Hill Chambers, E.C., chartered accountant; and W. J. Davis, 56, Milkwood Road, Herne Hill, S.E., clerk. No initial public issue. The number of directors is not to be less than three nor more than eight; the subscribers are to appoint the first; qualification, 250 shares. Registered office, Donington House, Norfolk Street, Strand, W.C.

H. J. Cash & Co., Ltd. (79,701).—This company was registered on January 9th, with a capital of £10,000 in £1 shares, to carry on the business of electrical, mechanical, heating and ventilating engineers, manufacturers of and dealers in electrical appliances, electrical contractors, fitters, and decorators, consulting engineers, draughtsmen, designers, &c. The first seven subscribers (each with one share) are:—H. J. Cash, 1, Belvedere Road, Lambeth, S.E., electrical engineer; H. T. Holloway, 19—21, Belvedere Road, Lambeth, S.E., contractor; H. Holloway, 19—21, Belvedere Road, Lambeth, S.E., contractor; S. Holloway, 19—21, Belvedere Road, Lambeth, S.E., contractor; C. Thomson, 59, Pont Street, S.W., merchant; C. J. Byworth, Narford, Lyford Road, Wandsworth Common, S.W., incorporated accountant; and H. T. Holloway, jun., 19, Cedars Road, Clapham Common, S.W., contractor's assistant. No initial public issue. The number of directors is not to be less than three nor more than seven; the first are J. T. Holloway, H. Holloway, S. Holloway, C. Thomson, C. J. Byworth and H. J. Cash (all permanent); qualification, £100; remuneration as fixed by the company. Registered office, 1, Belvedere Road, Lambeth, S.E.

Mechan & Sons, Ltd. (5,516).—This company was registered in Edinburgh on January 8th, with a capital of £200,000 in 10,000 preference shares of £10 each, and 100,000 ordinary shares of £1 each, to acquire as a going concern the business of Messrs. Mechan & Sons, of Scotstoun Iron Works, with the heritable and movable real or personal property belonging to them in connection therewith, and to carry on the business of engineers, marine, mechanical, electrical, hydraulic, mining and general engineers, machine and engine tool makers, engine and carriage builders, &c. The first subscribers (each with one share) are:—H. Mechan, Scotstoun Iron Works, Scotstoun, Renfrewshire, engineer; S. Mechan, Scotstoun Iron Works, Scotstoun, Renfrewshire, engineer; A. Mechan, Clifford Lodge, Largs, Ayrshire, engineer; Mrs. J. Mechan, 40, Montgomerie Drive, Kelvinside, Glasgow; Mrs. F. Mechan, 22, Kingsborough Gardens, Glasgow; A. Deas, 180, Hope Street, Glasgow, chartered accountant; and T. C. Young, 93, W. Regent Street, Glasgow, writer. The number of directors is not to be less than two nor more than five; the first are H. Mechan, S. Mechan and A. Mechan; qualification, £500; remuneration as fixed by the company. Registered office, Scotstoun Iron Works, Scotstoun, Renfrewshire.

Cambridge Electric Tramways Syndicate, Ltd. (79,744).—This company was registered on January 12th, with a capital of £5,000 in £10 shares, to adopt an agreement with the British Electric Traction Co., Ltd., for the acquisition of its interest in an agreement dated June 21st, 1898, between the Cambridge Street Tramways Co. of the one part, and the first-named company of the other part, and for the purchase by this company of certain shares held by the British Electric Traction Co., in the Cambridge Street Tramways Co., to construct, acquire, equip, maintain and work by electricity or other power any tramway or tramways in the town or county of Cambridge, and to carry on the business of tramway, railway, and omnibus proprietors, carriers of passengers and goods, &c. The first subscribers (each with one share) are:—D. Munsey, Beech House, Cambridge, jeweller, &c.; P. W. Latham, M.D., Rumplington Street, Cambridge; A. A. C. Swinton, 66, Victoria Street, Westminster, engineer; H. B. Harvey, 27, Park Parade, Cambridge, engineer; J. H. Taylor, 18, Tenison Road, Cambridge, secretary; A. W. Langley, 1, Carlisle Place, S.W., clerk; and C. A. Parsons, Heaton Works, Newcastle-on-Tyne, engineer. No initial public issue; registered without articles of association.

Canadian Electric Traction Co., Ltd. (79,722).—This company was registered on January 12th, with a capital of £120,000 in £1 shares, to construct, improve, work, lease, administer or control electric, steam, and other railways and tramways, and electrical storage, power and lighting works, and to carry on the business of carriers of passengers and goods, electrical engineers, electricians, engineers, contractors, manufacturers of, and dealers in, railway, tramway, electric, magnetic, galvanic, and other apparatus, mechanical and chemical engineers, generators, accumulators, transmitters, users and suppliers of light, heat, sound and power by electricity, galvanism, magnetism, compressed air, gas, steam, oil, or otherwise, &c. The first subscribers (each with one share) are:—W. J. Cox, 1, Metal Exchange Buildings, E.C., clerk; E. H. Bullock, 10, Soudan Terrace, Stromness Road, Southend-on-Sea, accountant; F. B. Fuller, 13, St. Helens Place, E.C., secretary; W. Buchanan, 15, Ethelden Road, Shepherd's Bush, W., draughtsman; M. B. Taylor, 3, Drayton Road, West Ealing, stenographer; H. P. Dakin, 9, Silverlock Street, Rotherhithe, S.E., cashier; and R. G. Cheshire, 14, St. Helens Place, E.C., clerk. The number of directors is not to be less than three nor more than eight; the subscribers are to appoint the first; qualification, £250; remuneration, £150 each per annum (£50 extra for the chairman).

East Cheshire Light Railways Syndicate, Ltd. (79,755).—This company was registered on January 16th, with a capital of £3,000 in £5 shares, to establish a company with powers under the Light Railways Act, 1896, to construct, maintain and work a system of light railways from Mottram to or near Hyde, Stalybridge, Hollingworth, Woolley Bridge, Tintwistle, Broadbottom and elsewhere; to acquire any tramways or railways in Cheshire or elsewhere in the United Kingdom, to equip, maintain and work the same by electricity, steam, horse or other power, to carry on the business of railway, tramway, motor-car, omnibus and van proprietors, manufacturers of rolling stock, carriers of passengers and goods, electricians, suppliers of electricity, and to adopt an agreement with A. E. Chadwick. The first subscribers are:—G. Pearson, Grenville House, Ashton-under-Lyne, coal factor, 11 shares; M. Fentem, J.P., Beechwood, Stalybridge, merchant, 10 shares: L. H. Moorsom, 20, Cooper Street, Manchester, engineer, 11 shares; J. Ridyard, J.P., High Bank, Stalybridge, gentleman, 10 shares; A. H. Gibbings, Lynton, Heaton Norris, electrical engineer, 10 shares; J. M. Newton, 6, Bank Street, Manchester, engineer, 10 shares; and W. E. Rowcliffe, 37, Cross Street, Manchester, solicitor, 10 shares. Minimum cash subscription, £1,000. The number of directors is not to be less than three nor more than 12; the first are G. Pearson, M. Fentem, J.P., L. H. Moorsom, J. Ridyard, J.P., and A. H. Gibbings; qualification, £50; remuneration as fixed by the company. Registered office, 129, Stamford Street, Stalybridge.

Peto & Radford, Ltd. (79 761) —This company was registered on January 16th, with a capital of £40,000 in £1 shares, to adopt two agreements —(1) with Peto & Radford, Ltd., and (2) with the P. and R. Storage Battery Co., Ltd., and to carry on the business of manufacturers of and dealers in electric meters and any other electrical instruments, apparatus, appliances, machines and contrivances, electricians, accumulator manufacturers, photographers, automatic manufacturers, opticians, photographic printers, stationers, engravers, typefounders, &c. The first subscribers (each with one share) are:—W. Peto, Sunnybank, Ashstead, Surrey, electrical engineer; F. W. A. Radford, Southernhurst, South Park Hill, Croydon, electrical engineer; F. G. Hart, Station Road, Epping, electrical engineer; H. J. Day, 66, New Compton Street, W.C., electrical engineer; E. Mumford, 25, Nelson Street, Greenwich, pawnbroker; W. A. Carroll, 63, Spencer Street, E.C., electrician; and C. W. Marshall, 19, Elm Park Road, Chelsea, assessor of taxes. No initial public issue. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first; remuneration as fixed by the company.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Automatic Telephone Co. (1903), Ltd. (76,025).—A mortgage, dated December 2nd, 1903, to secure £950, charged on plant and machinery on the premises of Messrs. Margo & Co., of 72 and 74, London Street, Greenwich, has been registered. Holder: Mrs. D. Margowski, 18, Newstead Road, Lee, Kent.

Fenner James & Co., Ltd., electricians, London (76,952).—A debenture, dated December 18th, 1903, charged on the company's undertaking and property, present and future, including uncalled capital (if any), has been registered. Holder: Capt. W. A. Grant, Castle Malwood, Lyndhurst, Hants.

Electric Light Insurance and Maintenance Co., Ltd. (64,399).—This company's annual return was filed on November 2nd, when 6,329 shares had been taken up out of a nominal capital of £10,000 in £1 shares. £1 per share has been called up on seven shares, and 10s. per share on 5,882, resulting in the receipt of £2,843. £75 remains in arrears. £3,411 is considered as paid, being £1 per share on 500 and 10s. per share on 5,882 shares. Mortgages and charges: £5,000.

Chelmsford Electric Lighting Co., Ltd.—A trust deed, dated December 21st, 1904, to secure £20,000 debenture stock, has been registered. Property charged: The company's personal property, including uncalled capital and unpaid calls, goodwill, trade debts and other choses in action, and certain freehold lands and hereditaments at Chelmsford. Trustees: Lieut.-Colonel R. E. B. Crompton, C.B., Thriplands, Kensington Court, W.; and B. Gibson, 31, Warrington Crescent, Maida Vale, W.

Ross Electric Light and Power Co., Ltd.—£1,500 debentures, created and dated December 17th, 1903, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

Costa Rica Electric Light and Traction Co., Ltd.—A principal trust deed, dated March 30th, 1898, to secure £130,000 debentures, created March 14th, 1898, and a supplemental trust deed, dated December 23rd, 1903, to secure £100,000 further debentures created November 25th, 1902, have been registered. Property charged: Contracts or concessions giving the right to use the waters of the rivers Maria, Aguilia, Tiribi, Varilla, Torres and Cartago, having horse-power of about 1,360, with power houses and other works used in connection therewith, land at Anonos, San José, and Cartago, and the company's undertaking and property, present and future, including uncalled capital. Trustees: City Safe Deposit and Agency Co., Ltd.

Chloride Electrical Storage Co., Ltd. (35,389).—This company's annual return was filed on November 10th, when 62,000 preference and 33,250 ordinary shares had been taken up out of a nominal capital of £135,250 in 62,000 preference, 33,250 ordinary, and 40,000 unclassified shares of £1 each. £1 per share has been called up on 48,750 preference and 16,250 ordinary shares, and £65,000 has been received. £30,250 is considered as paid on 13,250 preference and 17,000 ordinary. Mortgages and charges: £20,000.

Northampton Electric Light and Power Co., Ltd. (28,640).—Issue, on January 2nd, of £1,150 debentures, part of series created June 3rd, 1896, to secure not more than two-thirds of the paid-up capital for the time being, charged on the company's undertaking and property, present and future, including, uncalled capital. No trustees. Previously issued of same series: £30,550.

Perth Electric Tramways, Ltd. (55,935).—A trust deed, dated December 30th, 1903, to secure £50,000 debentures, created by resolution of December 22nd, 1903, has been registered. Property charged: The benefit of certain agreements, deposit, provisional order and Acts of Parliament and tramways, tramway undertaking, plant, machinery, &c., in Perth, West Australia. Trustees: Lord A. Butler, 7, Portman Square, W., and J. S. Austen, 68, Dashwood House, E.C.

Bath Electric Tramways, Ltd. (74,278).—A memorandum of satisfaction in full of two mortgages on unpaid capital, dated August 29th and September 15th, 1903, securing £10,000 and £15,000 respectively, has been filed.

Pacific and European Telegraph Co., Ltd. (36,683).—This company's annual return was filed on December 17th, when the entire capital of £100,000 in £10 shares had been taken up. £4 per share has been called up, resulting in the receipt of £40,000. Mortgages and charges: £100,000.

Hubert Grenfell, Ltd. (43,086).—This company's annual return was filed on November 26th, when 1,345 preference and 10,000 ordinary shares had been taken up out of a nominal capital of £12,500 in 2,500 preference and 10,000 ordinary shares of £1 each. £1 per share has been called up on the preference, resulting in the receipt of £1,345. £10,000 is considered as paid on the ordinary shares. Mortgages and charges: Nil.

Marconi International Marine Communication Co., Ltd. (65,759).—This company's return for 1903 was filed on January 2nd, when 204,056 shares had been taken up out of a nominal capital of £350,000 in £1 shares. 15s. per share has been called up on 99,056 shares, resulting in the receipt of £74,179. £113 remains in arrears. 105,000 shares are considered as fully paid. No mortgages or charges.

New Phonopore Telephone Co., Ltd. (44,654).—This company's annual return was filed on October 20th, when 5,111 ordinary and 1,000 founders' shares had been taken up out of a nominal capital of £10,000 in 9,000 ordinary and 1,000 founders' shares of £1 each. 10s. per share has been called up on the ordinary, resulting in the receipt of £2 555 10s. 1,000 founders' shares are considered as fully paid. No mortgages or charges.

ELECTRIC TRAMWAY ACCOUNTS.

East Ham and Wolverhampton Municipal Tramways.

OUR analysis this week deals with two municipal tramway undertakings which apparently have very different aims in view. East Ham has gained a reputation for cheap rides, 82 per cent. of the fares being ½d., and the average fare being ·62d. Wolverhampton, on the other hand, by its decision to soar above the level of common or garden trolley systems, and thus enable its population to enjoy to the full an unobstructed view of "beautiful Wolverhampton," is doing its best to increase the cost of travelling, and its revenue per passenger amounts to 1·2d., or double the East Ham figure.

The results are of the first complete 12 months' working at East Ham, and, compared with the previous nine months' excellen results, show a considerable improvement.

In the case of Wolverhampton the figures do not represent a clear year's working of the reconstructed routes, the dates of opening of the latter being from February 6th to September 24th 1902. It will be gathered that a deficiency occurred on the working of the horse section, which was made good from the balance on the electrical sections, the deficit for the year on all sections being £257. Mr. W. C. Ullmann is the engineer and manager of the East Ham D.C. tramways, and Mr. W. A. Luntley and Mr. C. E. C. Shawfield are manager and engineer respectively, of the Wolverhampton undertaking.

GENERAL STATEMENT.

—	East Ham.	Wolverhampton. (Electrical Sections.)
For 12 months ending ...	March 31, 1903	March 31, 1903.
Length of route	7 miles	7 miles
Total length of track ...	11 miles	11 miles
Number of cars in use ...	30	14
Car-miles run	650,224	417,335
Passengers carried per annum	9,971,337	4,263,066
Capital expended to date ...	£127,943	£147,552
Total receipts	£26,099	£21,353
Working expenses	£18,661	£12,670
Gross profit	£7,438	£8,683
Income per car-mile	9·63d.	11·18d.* 12·28d.
Working expenses per car-mile	6·88d.	7·75d.* 7·28d.
Int. & sinking fund per car-mile	2·09d.	2·83d.* —
Total expenses per car-mile...	8·97d.	10·58d.* —
Profit or loss per car-mile ...	+·66d.	+·60d.* —
Cost of energy per car-mile ..	2·02d.	— 2·80d.
Average fare per passenger...	·62d.	— 1·24.
Revenue per mile of route ...	£3,728	£3,050
Expenditure per mile of route	£2,666	£1,810
Total units used	656,125	612,240
Units used per car-mile ...	1·01	1·46

* These results are for both electrical and horse sections.

The above figures show that East Ham is happily placed as regards a frequent service and heavy traffic, an excellent combination from the point of working efficiency. The passengers carried per car-mile at East Ham and Wolverhampton are 15 and 10 respectively, and by comparison the latter town offers far less chances of revenue-earning than the former, yet the working costs, and particularly the figure for energy per car-mile at Wolverhampton (with only some months working to its credit), shows that those items are likely to be considerably above the average for such undertakings.

ANALYSIS OF WORKING EXPENSES.

—	East Ham. Gross.	East Ham. Per car-mile.	Wolverhampton. Gross.	Wolverhampton. Per car-mile.
Traffic expenses, including wages of employés, car-shed expenses, tickets, uniforms	£8,897	3·28d.	£5,085	2·93d.
Electrical energy	5,468	2·02d.	4,868	2·80d.
Management and general expenses, including salaries, printing, stationery, insurance, law and sundry ...	1,194	·44d.	1,236	·71d.
Rent, rates and taxes ...	712	·26d.	375	·21d.
Repairs and Maintenance :—				
Track...	324	·12d.	155	·09d.
Overhead equipment ...	144	·05d.	*26	*·02d.
Cars, &c.	1,797	·66d.	896	·51d.
Sundry	125	·05d.	29	·01d.
Total working expenses ...	£18,661	6·88d.	£12,670	7·28d.
Percentage of working expenses to receipts	71 per cent.		60 per cent.	

* Feeders and conduits (Lorain surface contact system installed).

The East Ham working expenses are somewhat above the average for trolley lines, but the car-miles on the same length of route are ⅓rd more than at Wolverhampton, and maintenance charges are correspondingly increased.

The Wolverhampton figures also do not include expenditure by the Lorain Co. on renewals, amounting to £850 or an additional ·49d. per car-mile, which, if added, would bring up the working expenses to 7·77d. per car-mile, a figure which is likely to increase with a complete year's working. The percentages of working expenses to receipts show clearly the effect of the low average fares charged in the case of East Ham.

PROFIT STATEMENT.

	East Ham.	Wolverhampton.
To interest on loans	£3,603	£4,353
To sinking fund	2,047	2,226
To depreciation and reconstruction	—	2,995
To deficit on horse section ...	—	702
To accumulated interest	—	—436
To balance for year	1,788	—257
Gross profit ...	£7,438	£8,683

In the case of East Ham, the gross profit provided for financial charges, and left a balance of £1,788, which was carried towards the liquidation of the initial expenses.

At Wolverhampton the profit on the electrical sections covered the deficiencies of the horse tramways; provided for financial charges; also for depreciation on the old horse undertaking, and reconstruction of tracks and cars (exclusive of Lorain equipment), the latter an item of £1,750, which presumably does not refer to running maintenance. The net result of the year's working, after adding an amount of £436, in respect of accumulated interest, is a deficiency of £257.

CITY NOTES.

Direct United States Cable Co.

THE directors' report for the six months ended December 31st, 1903, to be presented at the meeting on Tuesday, January 26th, shows:—

The half-year's revenue, after deducting out-payments, amounted to £47,815, as compared with £52,544, showing a difference of £4,729 against the half-year under review. The working and other expenses amounted to £21,816, leaving a balance of £25,999 as the net profit, making, with £2,634 brought forward from the previous half-year, a total of £28,692. For the corresponding period of 1902, the working expenses and other payments amounted to £21,747. Interim dividends of 3s. per share for the quarter ended September 30th, 1903 (paid October 27th, 1903), and of 3s. per share for the quarter ended December 31st, 1903, payable January 30th, 1904), together amounting to £18,219, have been declared, and after setting aside £8,000 to the reserve fund account, the balance of £2,479 on the revenue account has been carried forward. The reserve fund account has been debited with £30,178 for cost of cable repairs, and after being credited with interest on the investments, profit on sale of securities and amount set aside from revenue now amounts to £462,094, taking the investments at cost price.

City and South London Railway Co.—The accounts for the half-year ended December 31st, 1903, show a balance sufficient, after providing for debenture stock interest, dividend on the preference stocks and transferring to the renewal fund £1,500, to allow of a dividend on the consolidated ordinary stock at the rate of 2 per cent. per annum, carrying forward a balance of £746. The dividend for the corresponding period last year was at the rate of 3½ per cent. per annum, carrying forward a balance of £1,268.

Stock Exchange Notices.—Applications have been made to the Committee to appoint a special settling day in:—

West London and Provincial Electric Supply Co., Ltd.—Further issue of 5,763 ordinary shares of £1 each, fully paid, Nos. 19,892 to 25,654; and 5,763 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 41,915 to 47,677.

And to allow the following to be quoted in the Official List:—

London United Tramways (1901), Ltd.—Further issue of 17,500 5 per cent. cumulative preference shares of £10 each, fully paid, Nos. 82,501 to 100,000.
Isle of Wight E. L. and P. Co., £50,000 4½ per cent. debenture stock.

Crompton & Co., Ltd.—The secretary states that the keen competition in the electrical trade, referred to in the chairman's speech at the last general meeting, still continues, and although a larger amount of business has been done during the half-year ended September 30th last than in any corresponding period in the company's history, prices have ruled so low that only a moderate profit had been earned after providing for debenture interest. The directors have, therefore, decided to await the results of the full year's working before making any distribution to the shareholders.

Dublin and Lucan Electric Railway Co.—The accounts for the half-year ended December 31st, 1903, show a profit of £1,625. After including the balance brought forward and providing for debenture interest, the directors recommend the payment of half-year's dividend on the preference shares, placing £700 to reserve fund, and carrying forward £359.

St. James's and Pall Mall Electric Light Co.—The directors recommend a dividend for half-year ending December 31st of 7s. 6d., together with a bonus of 2s. per share on the ordinary shares, making with the interim a dividend of 12½ per cent., and a bonus of 2 per cent., for the year 1903.

Metropolitan Railway Co.—The dividend for the past half-year is at the rate of 3 per cent. per annum, with £11,500 placed to reserve and £21,000 carried forward.

Smithfield Markets Electricity Supply Co.—The directors recommend a dividend of 4 per cent. for year ended December 31st last, carrying forward £1,250.

Chili Telephone Co.—The directors have declared an interim dividend at the rate of 6 per cent. per annum for the six months ended September 30th, 1903.

Great Northern and City Railway Co.—This company's meeting is to be held at River Plate House, E.C., on February 2nd, at 2.30 p.m.

Central London Railway Co.—The ordinary meeting is to be held at the Holborn Restaurant on 3rd prox., at 12.30 o'clock.

STOCKS AND SHARES.

Wednesday Evening.

FOREIGN politics having fallen upon something of a lull, the Stock Exchange is busy discussing its own domestic concerns, which invariably come to the fore when there is not much business doing. The Home Railway provides an unwonted excitement, thanks to the dividends, but beyond that, the daily chronicle sinks to much about the same dead level of inanition every day. A few of the electric lighting companies are declaring their dividends, to the hardening of the market, but Telegraph descriptions display few changes.

Two per cent. on City and South London Ordinary Stock was as much as the most hopeful had looked for, while others, as we have previously mentioned, thought that the dividend might be passed altogether this half-year. The rate makes 2⅜ per cent. for 1903, against the 3¼ per cent. paid in the previous twelve month, and the price of the stock has risen two points, to 50½. At the present price of 50, the yield is, of course, 4¾ per cent. on the money. The Preferences have also firmed up a trifle.

Another surprise was the Metropolitan Railway dividend at the rate of 3 per cent. per annum, which also advanced the price a couple of points, to 89. These distributions, with others of the steam companies, are better than the market had anticipated, and as there is not much stock in floating supply, a small boomlet appears at least possible in the Home Railway department. Great Northern and City Preferred "A" shares have come into notice upon the preliminary running of the system, and are being dealt in about 7½ to 7¾. The Great Northern Railway is making sweeping alterations in its fares, to compete with its electrical neighbour. Districts remain quiet at 35, which is fractionally higher on the week; the Metropolitan dividend being an influence for good. Up to the time of writing on Wednesday evening, the Central London has not made its announcement, but 4 per cent. on all the stocks, and a reduced carry-forward is anticipated.

The St. James's and Pall Mall is the first of the big electric lighting companies to announce its dividend, and the rate of 14½ per cent. maintains that which has been paid for several years past. While the quotation is nominally unchanged, the tone has improved—that is to say, the buyer now would have to pay more for his shares than a week ago. The same observation applies to several of the other principal shares in this list. London Electric Preference improved to 5⅜, another 5s. rise, and Kensingtons are ½ better at 11½, the same advance having been scored by Westminsters at 13. Westminster Preference are 6¼ *ex* the dividend of half-a-crown, the deduction failing to change the price, which is also the case with Edmundson's Ordinary in all respects. Smithfields have declared a higher dividend at the rate of 4 per cent., and the shares keep about 3¼, while the Debentures are being done at 85½ and 85⅝. Blackheath Ordinary at ⅞ has risen ½, a sequel to the demand for the shares which we were noticing last week. Metropolitans are inclined to be easier as a result of Tuesday night's meeting at Queen's Hall.

Among Telegraph descriptions, the stolidity of the Eastern group is, perhaps, the outstanding feature. What changes have occurred are little more than the adjustment of prices to *ex* dividend conditions. Eastern Extensions are theoretically 5s. down, although the dividend is only 2s. 6d., but since the price of the shares moves (officially) in quarters actual alteration is not represented thereby. The leading financial weekly journal calls attention to the unreliable way in which too many shares are officially quoted, and its strictures might, perhaps, be applied more aptly to electric lighting and telegraph varieties than to almost anything else.

Anglo-American Telegraph Preferred at 94 is 2 better, and the directors are expected to make their dividend statement on January 29th. Direct Spanish Preference have put on ½, at 8 middle, but the Debentures lost their rise of last week. None of the Telephone issues have moved.

In the Traction market there is very little doing. London United Debenture has been done at 104½, and the omnibus companies' stocks are advancing upon the better display made by the Road Car dividend. British Electric Traction Ordinary do not move from 11½. Calcutta tramways have been dealt in at 6⅜.

Cromptons fell ¼ to 1¾ upon the disappointing nature of the report; the interim dividend has to be passed, owing to the decline in the profits. British Westinghouse Preference have hardened to 4½, and it is said that the dividend is to be paid directly after the meeting on February 5th. The Debentures are 94½, and not a particularly good market at that. British Aluminium Debenture easily recovered 1½ per cent. of the deducted interest. Telegraph Constructions continue dullish, and there are no changes to report in the Callender and Henley groups.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1901.	1902.	1903.	Closing Quotations Jan. 13th.	Closing Quotations Jan. 20th.	Business done week ended Jan. 20th, 1904. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102	98 —102	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2⅛ — 3⅛	2⅛ — 3⅛	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	61s.	60/6	..	49 — 52	49 — 52	..	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	..	92 — 94	94 — 96	96	94
3,105,580	Do. do. do. Deferred	Stock	2s.	1/-	..	7⅛ — 8	7⅛ — 8	8	7
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	6 %	..	4⅜ — 5¼	4⅜ — 5¼	..	..
18,333,300$	Commercial Cable	$100	8 %	8 %	..	175 —185	175 —185	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	88 — 92	88 — 92	89	..
16,000	Cuba Telegraph	10	4 %	6⅔%	..	7 — 8	7 — 8	..	..
6,000	Do. 10 % Pref.	10	..	..	..	16 — 17	16 — 17	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	..	2⅛ — 3⅛	2⅛ — 3⅛	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7⅛ — 8⅛	..	..
80,000	Do. do. 4½ % Debs.	50	..	..	..	100 —103 %	98 —101%	..	..
60,710£	Direct United States Cable	20	3¼%	3¼%	..	10 — 10⅝	10 — 10¼	..	..
85,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	121 —126	119 —124 xd	122	119½
1,955,565	Do. 3½ % Pref. Stock	100	..	..	..	87 — 90	87 — 90 xd	..	..
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —108	105 —108	..	..
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	..	11 — 11⅛	10⅞ — 11⅛ xd	11⅛	..
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	106 —109	106 —109	..	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	..	..	..	99 —102	99 —102	100¼	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	99 —102	99 —102	100⅛	..
180,227	Globe Telegraph and Trust	10	5⅛%	..	..	8⅛ — 8¾	8⅛ — 8¾	8 1/16	8⅝
180,042	Do. do. 6 % Pref.	10	..	..	..	12⅛ — 13	12⅛ — 13	12 1/16	12 3/16
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	12½%	..	24½ — 25½	24½ — 25½	25⅛	..
58,700	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
17,000	Indo-European Telegraph	25	10 %	10%	..	37 — 40	37 — 40	38½	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	98 —102	98 —102	..	..
1,988,333	National Telephone, Pref. Stock	100	5 %	6 %	..	102 —104	102 —104	103	102
1,966,667	Do. do. Def. Stock	100	..	4½%	..	77 — 80	77 — 80	77½	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	..	13 — 14	13 — 14	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	..	13 — 14	13 — 14	14	..
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	..	5 — 5⅛	5 — 5⅛	5⅛	5
000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	..	95 — 97	95 — 97	96½	96
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	..	100 —102	100 —102	101½	..
179,313	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	..	⅞ — 1	⅞ — 1	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	..	..	..	1 — 1⅛	.. ..	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,889	Reuter's	8	5 %	..	..	6½ — 7½	6½ — 7½	..	..
3,308	Submarine Cables Trust	Cert.	..	..	..	118 —123	118 —123	118	..
58,000	United River Plate Telephone	5	7 %	7 %	..	5½ — 6	5½ — 6	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4¾ — 5¼	4¾ — 5¼	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	102 —105	102 —105	..	..
15,609	West African Telegraph, Shares	10	..	2 %	..	5 — 6	5 — 6	..	..
150,000£	West Coast of America, 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	..	..	..	95 — 98	95 — 98	..	..
267,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %	..	11¾ — 12¼	11¾ — 12¼	12⅛	12
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	99 —102	99 —102	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	98 —101	98 —101	..	..
88,321	West India and Panama Telegraph	10	..	..	..	⅜ — ½	⅜ — ½	..	..
84,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6 — 6½	6 — 6½	6⅛	6
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	4½ — 5½	4½ — 5½	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	99 —102	99 —102 xd	99	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	4½ — 5½	4½ — 5½	..	..
800,000£	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock	..	..	..	88 — 92	87 — 91 xd	..	..
100,000	British Electric Traction	10	9 %	8 %	..	11⅛ — 11⅜	11⅛ — 11⅜	11⅜	11 7/16
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	11⅛ — 11⅜	11⅛ — 11⅜	11⅜	11½
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	120 —123	120 —123	123	122½
100,000	British Insulated and Helsby Cables	5	10 %	10 %	..	6 — 6⅛	6 — 6⅛	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —107	102 —107	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	..	..	1/16 — 1/8	1/16 — 1/8	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	..	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	..	1⅛ — 1¼	1⅛ — 1¼	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	3 %	6 %	..	1⅛ — 1¼	1⅛ — 1¼	..	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	97 —100	97 —100	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	75 — 80	75 — 80	..	..
35,000	Callender's Cable Construction shares	5	20 %	15 %	..	11 — 12	11 — 12	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	104 —108	104 —108	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	4 %	4 %	..	91 — 94	91 — 94	94	92
494,093	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	..	98 —101	98 —101	..	..
494,993	Do. do. Def. do.	Stock	4 %	4 %	..	91 — 94	91 — 94	..	..
1,330,000	City and South London Railway	Stock	2 %	3½%	2⅔%	47 — 50	49 — 52	49½	48½
85,000	Crompton & Co., Nos. 1 to 85,000	3	7½%	5 %	..	1¾ — 2⅛	1⅝ — 2	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	97 —109	97 —100	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	Nil	..	..	0 — ¼	0 — ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	5	Nil	..	..	⅛ — 1⅛	⅛ — 1⅛	⅜	..
344,023£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	71 — 76	72 — 77	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	76 — 81	76 — 81	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	..	1⅝ — 1⅞	1⅝ — 1⅞	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	..	..	..	2⅛ — 3	2⅛ — 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	98 —101	97 —100 xd	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	9⅛ — 10	9⅛ — 10	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	95 — 98	95 — 98	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	..	13⅛ — 14⅛	13⅛ — 14⅛	14⅛	14⅛
35,000	Do. do. 4½ % Pref.	5	..	..	..	5 — 5⅛	5 — 5⅛	..	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	108 —112	108 —112	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	18 — 19	18 — 19 xd	18⅝	..
300,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	1½%	..	4⅞ — 5	4⅞ — 5	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10¼ — 10½	10 — 10¼	..	..
37,350	Telegraph Construction and Maintenance	12	20 %	20 %	..	33 — 36	34 — 37	34⅜	33
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	100 —103	100 —103 xd	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3⅛%	..	91 — 94	91 — 94	..	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 4 per cent. (September 3rd. 190

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME,	Stock or Share.	Dividends for the last three years. 1901.	1902.	1903.	Closing Quotations Jan. 13th.	Closing Quotations Jan. 20th.	Business done week ended Jan. 20th, 1904. Highest	Lowest
		‡							
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	1	..	..	..	⅜— ⅞	¾— 1	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	100	..	..	..	114 —117	114 —117	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	8 %	8 %	..	10 — 10½	10 — 10½	..	..
20,000	Do. do. 7 % Cum. Pref. ..	5	..	..	..	9⅞— 10½	9⅞— 10½	..	..
50,000	Charing Cross and Strand Electricity Supply	5	10 %	10 %	..	8½— 9½	8½— 9⅝	8⅝	..
70,000	Do. do. do. 4½% Cum. Pref. ..	5	..	..	..	5½— 5⅝	5½— 5⅝	..	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	..	..	..	4⅝— 5	4⅝— 5	..	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	103 —105	103 —105	..	..
44,486	*Chelsea Electricity Supply, Ord.	5	4 %	4⅓%	..	5½— 6	5½— 6	..	..
150,000‡	Do. do. % Deb. Stock Red.	Stock	..	..	..	105 —108	105 —108	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595	10	5 %	5 %	..	10¼— 10¾	10¼— 10¾	10⅝	10⅝
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	..	..	..	13 — 14	13 — 14	13⅝	13⅝
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	121 —126	121 —126	124⅛	124
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	101 —104	101 —104	103⅜	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	10	4 %	4 %	..	7⅞— 8½	7⅞— 8½	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000..	10	..	..	..	11⅜— 12⅝	11¼— 12½	11⅝	11⅛
400,000‡	Do. do. 4½% Deb. Stock	..	..	..	..	107 —110	107 —110	109	108⅛
250,000	Do. do. 4½% 2nd Deb. Stock	Stock	..	..	..	99 —102	99 —102	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	..	6 — 6½	6 — 6½ xd	6⅜	..
80,000	Do. do. 6 % Cum. Pref.	..	..	..	..	6 — 6½	6 — 6½	..	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	..	..	..	104 —107	103 —106 xd	..	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	10 %	10 %	..	10½— 11½	11 — 12	..	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	..	..	..	101 —104	101 —104	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	1⅜— 2⅛	1⅜— 2⅛	1⅛	1⅛
49,840	Do. do. do. 6 % Pref.	5	..	..	..	5½— 5⅞	5½— 6	6⅛	..
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	97 —100	97 —100	97½	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6½%	7½%	..	17 — 18	17 — 18	17⅝	17½
71,106	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	5	..	..	..	5½— 5⅝	5½— 5⅝	..	..
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	109 —113	109 —113	..	..
250,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	95 — 98	95 — 98	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	..	12½— 13½	12½— 13½	13½	13
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14½— 14¾	14½— 15½	15	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	..	..	..	8 — 9	8 — 9	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	100	..	..	..	98 —101	98 —101	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	2½%	4 %	3 — 3½	3 — 3½	3⅜	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	..	..	..	85 — 90	85 — 90	83⅝	85⅛
65,000	South London Electricity Supply, Ord.	5	..	1¾%	..	3½— 3⅝	3½— 3⅝	..	..
80,000	Urban Electric Supply, Ord.	5	..	..	..	4½— 5⅛	4½— 5⅛	..	..
30,000	Do. do. 5 % Cum. Pref.	5	..	..	..	4½— 5⅛	4½— 5⅛	..	..
110,000	Westminster Electric Supply, Ord.	5	10½%	12 %	..	12 — 13	12½— 13½	12⅛	12⅜
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6 — 6½	6 — 6½ xd	6	..

*Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, January 20th.

CHEMICALS, &c.

		Latest Price.	Week's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a ,, ,, ...	per ton	£30	..
a Bleaching powder	per ton	£4 10	..
a Bisulphide of Carbon	per ton	£15	..
a Borax	per ton	£13	..
a Benzole (90 %)	per gal.	7/-	..
a ,, (50/90 %)	per gal.	5/6	..
a Copper Sulphate	per ton	£20	..
a Lead, Nitrate	per ton	£24	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90% a 160° C).	per gal.	5/6	..
a Potash, Bichromate, in casks ..	per lb.	8d.	..
a ,, Caustic (75/80%).. ..	per ton	£24	..
a ,, Bisulphate	per ton	£35	..
a Shellac	per cwt.	226/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a ,, Crystals	per ton	£8	..
a ,, Bichromate, casks.. ..	per lb.	2½d.	..

METALS, &c.

b Aluminium Ingots, in ton lots ..	per ton	£130	..
b ,, Wire, in ton lots ..	per ton	£168	..
b ,, Sheet, in ton lots ..	per ton	£166	..
p Babbitt's metal ingots	per ton	£48 to £130	..
c Brass (rolled metal 2' to 12') basis	per lb.	7d.	..
c ,, Tube (brazed)	per lb.	9d.	..
c ,, ,, (solid drawn).. ..	per lb.	7¾d.	..
c ,, Wire, basis..	per lb.	7¼d.	..
c Copper Tubes (brazed)	per lb.	9½d.	..
c ,, ,, (solid drawn) ..	per lb.	9⅝d.	..
g Copper Bars (best selected ..	per ton	£73	..

METALS, &c. (*continued*).

		Latest Price.	Week's Inc. or Dec.
g Copper Sheet	per ton	£73	..
g ,, Rod	per ton	£73	..
c ,, (Electrolytic) Bars ..	per ton	£63	..
c ,, ,, Sheets ..	per ton	£78	..
c ,, ,, Rod ..	per ton	£75	..
c ,, ,, H.C. Wire	per lb.	7¼d.	..
f Ebonite Rod	per lb.	3/3	..
f ,, Sheet	per lb.	3/-	..
n German Silver Wire	per lb.	1/6	..
h Gutta-percha fine	per lb.	3/-	..
h India-rubber, Para fine	per lb.	4/- to 4/1½	inc.
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	42/9	..
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g Lead, English Ingot	per ton	£12	..
g ,, ,, Sheet	per ton	£13	..
m Manganin Wire No. 28	per lb.	3/-	..
g Mercury	per bot.	£8 5	..
d Mica (in original cases) small ..	per lb.	4d. to 1/6	..
d ,, ,, medium	per lb.	2/6 to 3/9	..
d ,, ,, large ..	per lb.	4/- to 7/9	..
p Phosphor Bronze, plain castings	per lb.	1/- to 1/3½	..
p ,, rolled bars & rods	per lb.	1/- to 1/3	..
p ,, ,, strip & sheet	per lb.	From 1/1	..
o Platinum	per oz.	£4	..
p Silicium Bronze Wire	per lb.	9d. to 11d.	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block	per ton	£136 10 to £137 10	..
g ,, Foil	per lb.	1/6	..
n ,, Wire, Nos. 1 to 16	per lb.	1/8	..
p White Anti-friction Metals—			
"White Ant" brand ..	per ton	£42 to £62	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j ,, 6 lea. Flax	per lb.	5½d.	..
j ,, 3 ply 10 lbs. Russian ..	per lb.	4⅛d.	..
j ,, 10 lbs. Russian, single ..	per lb.	4½d.	..
j ,, 180 lbs. Jute rove ..	per ton	£11	..
k Zinc, Sh't's (Vieille Montagne bnd.)	per ton	£24 15	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS

	Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
British Elec. Tramways Co.	Aberdeen	Jan. 16	1,051	+336	33	40,909	+ 7,678	10	—
	Birmingham ..	,, 16	5,022	+673	3	15,375	+ 1,024	3½	—
	Bournemouth ..	,, 13	887	—	—	—	—	10½	—
	Blackburn	,, 15	705	+ 81	—	35,502	+ 1,454	13½	—
	Blackpool	Dec. 24	287	— 18	—	37,608	— 159	8½	—
	,, —Fleetw'd	Jan. 16	159	— 3	3	410	— 51	7½	—
	,, —Lytham	,, 14	136	+116	11	1,591	+ 1,046	7½	—
	Bolton	,, 17	1,628	+195	42	77,145	+ 8,619	25	—
	Bradford	,, 17	3,416	+560	40	157,837	+20,905	77	—
	Brighton	,, 17	741	+ 97	—	38,496	—	7½	—
	Bristol	,, 15	4,548	+529	—	—	—	28	—
	Devonport ..	,, 8	470	+ 89	1	540	+ 41	5	—
	Dudley—Sto'rb'ge	,, 8	688	+ 14	1	768	— 77	18½	—
	Gateshead ..	,, 8	833	+ 48	1	1,008	— 82	10½	+ ⅜
	Gr'n'k—Pt. Glsgw	,, 8	502	+ 87	1	599	— 11	7½	—
	Hartlepool ..	,, 8	243	+ 39	1	289	+ 9	6½	+2
	Middleton	,, 8	235	+ 10	1	281	— 37	8½	—
	Oldham—Ashton	,, 8	476	+ 28	1	561	— 102	8	—
	Potteries	,, 8	1,464	— 10	1	1,623	— 216	28¾	—
	Southport	,, 8	282	+ 26	1	276	— 13	5½	—
	South Staffs. ..	,, 8	658	— 16	1	787	— 106	21½	—
	Swansea	,, 8	450	+ 19	1	511	— 48	5½	—
	Wolverhampton..	,, 8	301	— 21	1	333	— 64	10½	+8
	Yorks. Wool Dist.	,, 8	526	—	1	589	—	6	—
	Miscellaneous ..	,, 8	1,189	—	1	1,360	—	—	—
	Burnley	,, 9	815	+140	—	—	—	7½	—
	Burton-on-Trent ..	,, 17	294	—	24	8,676	—	8½	—
	Cardiff	,, 10	1,823	+227	—	80,542	+20,880	1	—
	Chatham & District	,, 14	516	+141	2	1,011	+ 185	8·53	—

* Compared with the corresponding period of 1903.

Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open. *
Cork	Jan. 14	396	+ 54	2	812	+ 14	9 —
Dover	,, 16	170	+ 15	2	404	— 30	3 —
Dublin	,, 15	4,394	+465	3	9,436	+ 476	47 + ½
East Ham	,, 16	585	+160	—	27,949	+ 7,876	5 + ½
Glasgow	,, 16	12,656	+1998	33	451,961	+47,683	69½ +7½
Halifax (2 weeks) ..	,, 13	2,173	+ 72	41	55,826	+ 5,499	31½ +1½
Huddersfield ..	,, 16	1,185	+239	—	—	—	— —
Hull	,, 16	1,957	+302	42	79,690	+ 5,592	13 +2½
Ilkeston	,, 13	115	—	—	—	—	4 —
Ipswich	,, 16	307	—	—	2,346	—	7·86 —
Isle of Thanet ..	,, 16	217	+ 27	2	489	— 6	10½ —
Leeds	,, 16	4,877	+444	—	230,400	+14,075	41 —
Liverpool	,, 9	9,622	+295	2	19,318	+ 284	103 —
London C. C. ..	,, 16	9,085	+1966	41½	412,229	+74,245	39⅞ —
Manchester	,, 16	10,581	+2834	—	488,245	+268,221	72 —
Newcastle	,, 16	3,442	+646	—	—	—	17 —
Portsmouth	,, 16	1,356	+277	—	74,076	+ 4,597	14½ —
Salford	,, 11	3,569	+690	—	157,185	+44,675	30 —
Sheffield	,, 10	4,038	+227	2	8,658	+ 538	31⅝ +4
Southampton ..	Dec. 17	844	+ 17	—	—	—	16½ —
Southend-on-Sea ..	Jan. 13	186	+ 19	41	18,412	+ 2,098	8 —
Sunderland	,, 17	1,013	+107	42	51,360	+ 2,454	20 +3
Tyneside	,, 13	248	+ 90	2	501	+ 112	8·9 + ·43
Wolverhampton ..	,, 17	390	+ 44	—	—	—	9½ —
Cen. London Rly. ..	,, 16	7,057	—189	3	20,702	— 194	6 —
City & S. Lon. Rly. ..	,, 17	3,159	—304	3	9,564	— 746	6½ —
Dublin—Lucan Rly.	,, 17	95	+ 15	3	221	+ 11	6½ —
L'pool Overh'd Rly.	,, 17	1,569	+128	3	4,730	+ 221	6½ —
Mersey Railway ..	,, 16	1,395	+306	2	4,488	+ 1,269	4½ —

AUSTRALASIAN ELECTRICITY WORKS.

For the following particulars of electric lighting systems in West Australia, which should be added to the table published on p. 639 of our issue for October 16th, 1903, we are indebted to Mr. L. J. B. Wall, M.I.E.E., and M.A.I.E.E, of Perth:—

Locality.	Date of commencement of supply.	Supply authority or company.	Engineer or manager.	Secretary or town clerk.	System employed.	Voltage at consumers' terminals.	No. of 16-C.P. incand. lamps.	No. of arc lamps.	No. of consumers.	H.P. in motors.	Capacity of plant.	Boilers.	Engines.	Dynamos.	Price per unit. Lighting.	Price per unit. Power.	Remarks.
Northam	Nov., 1901...	Northam Municipal Council.	R. McDonald	A. L. Tait ...	D.C. three-wire.	220	2,500	10	180	—	90 kw.	1 Economic 1 Babcock	2 130-H.P. Sturtevant horizontal.	2 Sturtevant multipolar (40-kw. and 50-kw.).	10d.	—	—
Midland Junction	Nov., 1902...	Municipal Council.	E. Bindley ...	D. Pascoe ...	D.C. three-wire.	220	1,000	15	80	—	50 kw.	2 Economic	1 Sturtevant.	8 polar, 50-kw.	9d.	—	—
Bunbury...	May, 1903 ...	Splatt, Wall & Co.	F. Wilkinson	Splatt, Wall and Co.	D.C. three-wire.	220	1,500	12	100	60	60 kw.	2 Economic	2 55-H.P. Sturtevant horizontal.	2 30-kw. Sturtevant multipolar.	10d.	Contract	6 10-H.P. motors on electric winches for ship loading.
Subiaco ...	June, 1903...	Municipal Council.	W. H. James	A. Rankin ...	D.C. three-wire.	220	1,400	8	75	—	72½ kw.	2 Babcock	2 65-H.P. Peache.	2 36-kw. Crompton multipolar.	7d.	—	—
Cottesloe, Buckland Hill, and Peppermint grove.	March, 1901	Splatt, Wall & Co. (Private Act).	L. J. B. Wall (engineer).	J. W. James (manager).	D.C. three-wire.	220	2,500	5	140	25	80 kw.	2 Babcock	1 en. 35 and 40-H.P. Sturtevant, and 1 50-H.P. Mather and Platt.	1 30-kw. Sturtevant, 1 30-kw. Mather and Platt, and 1 20-kw. Crompton.	11d. to 9d.	9d. to 6d.	90 incand. street lights; Chloride battery.

SOME ELECTRICAL EXHIBITS AT THE FRENCH AUTOMOBILE EXHIBITION.

[BY OUR SPECIAL REPRESENTATIVE.]

(*Concluded from page* 117.)

Perhaps the most interesting feature of the *Salon* was the increasing number of "mixte" cars on view. The great drawback to the use of electrical vehicles is, of course, their limited range of mileage on one charge of the battery, and thus while admirably adapted for use in large towns and cities, they cannot compete, for long-distance and touring work, with the petrol car. For some time past a good deal of attention has been devoted to the question of combining the advantages of the electrical vehicle with those of the petrol car, as a result of which no less than five different types of combination petrol-electric, or "mixte" vehicles, as they are termed, were to be seen at the late Show. Among these was that of M. C. Mildé, to which we hope to refer at length in a subsequent issue.

Fig. 4 shows a plan view of the arrangement adopted in the "Electrogenia" cars of the Société de Constructions Electro-Mecaniques, of Levallois-Perret (Seine). Outwardly it resembles a petrol car, the motive power being supplied by a petrol engine comprising one, two or four cylinders according to the power required. This is directly coupled up through an elastic joint to a shunt-wound dynamo, which in turn transmits the electrical energy generated to a motor located at the rear of the frame, and driving the rear live axle through enclosed spur gearing. The motor is series excited, both the armature and field magnets having double windings. A feature of the system is that no rheostat is employed, the amperage and voltage of the motor being varied by the four

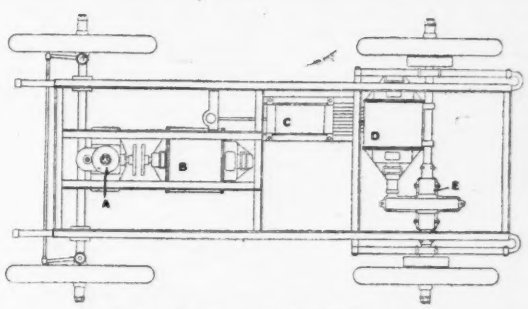


Fig. 4.—Plan of Electrogenia Car.

A, Petrol motor; B, Dynamo; C, Controller; D, Electric motor; E, Spur driving gear surrounding differential on rear ax. e.

different groupings of the double windings with which both the armature and the field magnets are provided, these being controlled by a special *combinateur*, in such a way as to utilise the electric current at the potential most suitable to the road being traversed. Intermediate speeds are obtained by the interposition of an auxiliary resistance in the exciting circuit. In some official trials made with a car of this type, the petrol engine developed 11·05 H.P. on the brake, and at the normal speed the dynamo developed 72 amperes at 95 volts or 6,840 watts, the efficiency of the generator being thus between 85 and 86 per cent., while the net percentage of the power developed by the generating set given off at the rear axle was 68·79, this comparing, according to the makers of the Electrogenia cars, with about 50 per cent. in the case of petrol motor vehicles. Not only is the efficiency high, but the consumption of petrol is exceedingly low, working out in the case of the 11-H.P. car mentioned above to only 13 litres per 100 kilometres, this result being attained in the course of a 750-mile tour, at an average speed of 28 miles per hour. The mechanism of the Electrogenia cars being all built on a straight *chassis*, any type of carriage body can be fitted thereto.

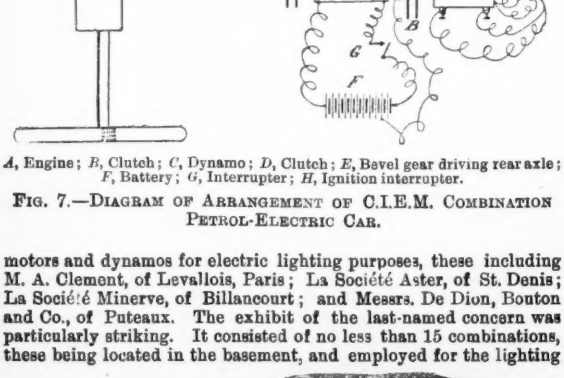
Another new "mixte" vehicle was to be found on the stand of the Compagnie Parisienne des Voitures Electriques, built to the designs of M. Krieger. Outwardly it closely resembles a petrol car, and is intended to afford all the advantages of the latter, combined with the quietness and flexibility in the way of speed of electrical vehicles. The motive power is supplied by a four-cylinder vertical petrol engine of 24 H.P. This is provided with all the modern fitments devised with the view of obtaining a large range of engine speed, and is connected up through a spring joint to a six-pole dynamo, the armature of which forms the fly-wheel of the engine. The current thus generated is conveyed to two small electric motors, each driving one of the rear road wheels through spur gearing. A small battery, weighing only 45 lbs., is carried to supply the current for exciting the dynamo and setting the engine in motion. It is not necessary to re-charge this battery, as any current used is replaced during the few moments it is connected up to the engine and dynamo, after the latter have been started. The employment of two independent motors obviates the use of a differential gear, while the absence of the usual friction clutch and mechanical change speed gear is claimed to result in an exceedingly easy and quiet-running vehicle at any speed from 6 to 45 miles per hour. For the forward speeds the car is entirely driven through the engine, that is to say, by varying the speed of this by means of the advance and retard of the ignition, and the throttle-valve on the mixture supply pipe; the reverse motion is obtained electrically. Complete with fuel and water, the car weighs about 25 cwt. Before

putting the vehicle on the market, M. Krieger submitted one to a 3,000-kilometre trial over a hilly route, which was accomplished without a single stoppage caused by defects in the mechanism.

Recognising the possibilities of the future, the Compagnie de l'Industrie Electrique et Mecanique (Brevets Thury), of Geneva, has also taken up the matter and produced a very interesting type of car.

The general arrangement of the vehicle is shown in fig. 7. It is made in two sizes, the motive power being supplied in one case by a two-cylinder 8-H.P. petrol engine, A, and in the other by a 16-H.P. one of four cylinders. This is connected up to a dynamo C, through the friction clutch B; the latter is operated by a pedal, which when depressed not only disengages the clutch, but breaks the ignition circuits at H. At D is another clutch by means of which the dynamo is connected to the shaft and bevel gearing which transmits the power to the rear axle. The system is completed by a battery of accumulators, F, and a current interrupter, G, operated by a pedal. The capacity of the battery can be suited to the work the car has to do, but the standard type is one of 30 ampere-hour capacity. The dynamo is designed to give a voltage equal to that of the battery, at an engine speed a little below the normal, on the level. In this way, should the speed of the engine exceed, say 1,000 revolutions per minute, and on a descent reach 1,200 revolutions, the voltage of the dynamo becomes above that of the battery, the latter then receiving the surplus charge. Reversely, on ascending a hill, as the speed of the engine, and consequently the voltage of the dynamo falls, the battery furnishes automatically the additional power required, the dynamo being so wound that it can be made to act as a motor. Furthermore, not only can the engine be automatically started, but the car can be entirely driven off the battery, through crowded traffic. In the cars fitted with a large battery, a distance of 20 to 30 miles can be run on the accumulators alone, with the engine stopped. The engine, dynamo and battery on the car, also practically form a portable electric lighting plant, the vehicle with the 30-ampere-hour set of accumulators being sufficient on one charge to light 50 10-C.P. lamps for an hour.

Quite a number of firms exhibited combination sets of petrol



A, Engine; B, Clutch; C, Dynamo; D, Clutch; E, Bevel gear driving rear axle; F, Battery; G, Interrupter; H, Ignition interrupter.

FIG. 7.—DIAGRAM OF ARRANGEMENT OF C.I.E.M. COMBINATION PETROL-ELECTRIC CAR.

motors and dynamos for electric lighting purposes, these including M. A. Clement, of Levallois, Paris; La Société Aster, of St. Denis; La Société Minerve, of Billancourt; and Messrs. De Dion, Bouton and Co., of Puteaux. The exhibit of the last-named concern was particularly striking. It consisted of no less than 15 combinations, these being located in the basement, and employed for the lighting

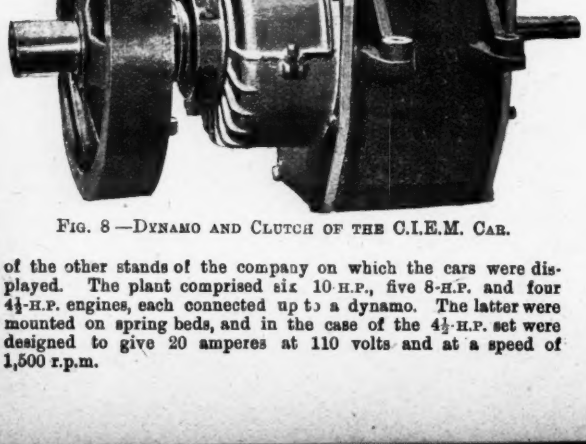
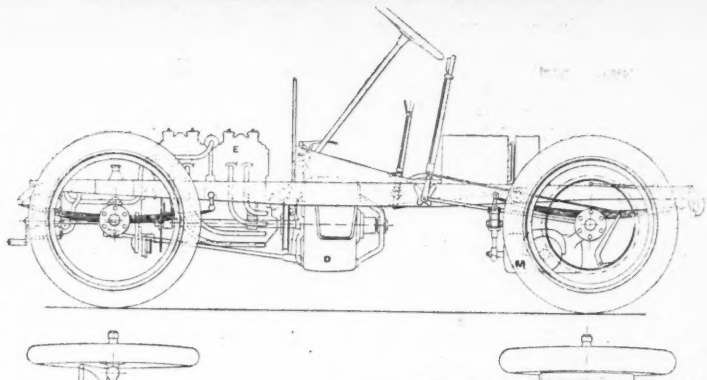
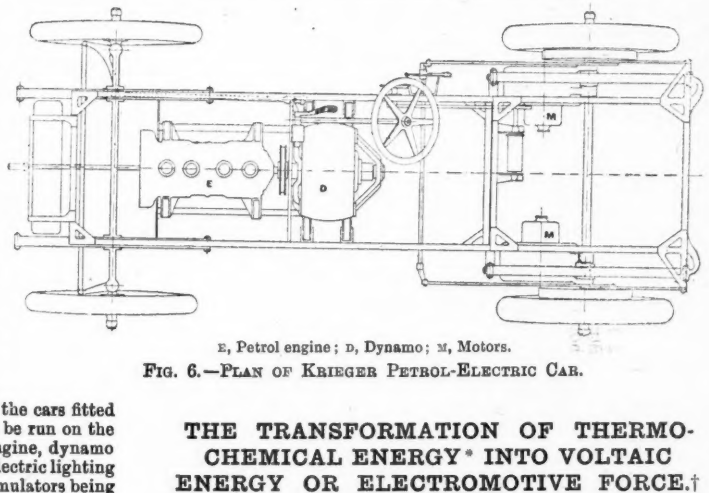


FIG. 8.—DYNAMO AND CLUTCH OF THE C.I.E.M. CAR.

of the other stands of the company on which the cars were displayed. The plant comprised six 10-H.P., five 8-H.P. and four 4½-H.P. engines, each connected up to a dynamo. The latter were mounted on spring beds, and in the case of the 4½-H.P. set were designed to give 20 amperes at 110 volts and at a speed of 1,500 r.p.m.

FIG. 5.—ELEVATION OF KRIEGER PETROL-ELECTRIC CAR.





E, Petrol engine; D, Dynamo; M, Motors.

FIG. 6.—PLAN OF KRIEGER PETROL-ELECTRIC CAR.

THE TRANSFORMATION OF THERMO-CHEMICAL ENERGY* INTO VOLTAIC ENERGY OR ELECTROMOTIVE FORCE.†

BY DR. D. TOMMASI.

A NUMBER of papers have lately been published relating to batteries with two liquids exercising a reciprocal chemical action (the action of a base upon an acid, for instance); we have thus been enabled to state that the nature of the electrodes plays a very important part with regard to the magnitude of the electromotive force developed by these batteries.

Thus, with unchangeable electrodes, we find that the electromotive forces of certain voltaic couples are often different from the electromotive forces calculated according to the heat of reaction, and, moreover, differing even for the same liquids, according to the nature of the metals that constitute the electrodes of these couples.

I had observed these facts, which are now being brought forward as new, as early as 1882, and I described them in a paper which I presented to the Académie des Sciences, Paris, and which had for its title, "Influence of the Positive Electrode of the Battery upon the Quantity of Heat Transmissible to the Circuit, under the Form of Voltaic Energy."‡

In this article I showed that, contrary to the general opinion, the electromotive force of the same voltaic couple varies according to whether its positive electrode consists of a metal that cannot be attacked, or of carbon.

A couple, for instance, that is incapable of effecting the electrolysis of water,§ or of a saline solution, although the heat given off by the couple is greater than that absorbed by the electrolyte, if its positive ‖ is of platinum, copper or silver, becomes capable of producing this decomposition if its positive electrode is of carbon. I will give an example:—

An acid couple consisting of chromic and sulphuric acid mixed ¶ would give off, according to Favre, 117·3 calories (2·5 volts) but only 32·5 cal. (1·35 volts), would be transmissible to the circuit.**

* Thermo-chemical energy is that which can be observed and measured with the aid of the thermometer; it is the energy produced in most batteries by the action of the zinc on the dilute sulphuric acid.

† The voltaic energy or electromotive force is the energy capable of provoking electrolytic decomposition; without, however, being capable of supplying it with the energy required in order to liberate the ions.

‡ See *Comptes Rendus de l'Académie des Sciences*, June 5th, 1882, and the "Traité des Piles Electriques," by D. Tommasi, pp. 61, 99, 144, 155 and 213.

§ The apparatus used for the electrolysis of water, or the voltameter, consisted of a glass vessel filled with acidulated water, in which were immersed two electrodes of platinum wire.

‖ The positive electrode of the voltaic couple, that is, and not the anode of the electrolyser or acidulated water voltameter, the electrodes in which are always of platinum.

¶ This couple consists of an outer glass jar containing an amalgamated zinc immersed in the dilute sulphuric acid, and a porous jar containing 25 grammes of chromic acid, 50 cubic centimetres of water, and 10 cubic centimetres of sulphuric acid.

** See "Traité des Piles Electriques," by D. Tommasi, p. 63.

It follows, therefore, that a single chromic acid couple should not decompose water acidulated with sulphuric acid.

In fact, if the positive electrode of this element is of platinum, the water of the voltameter * is not decomposed; but if the positive electrode of the couple is of carbon, or spongy platinum, the electrolysis of the water takes place.

The chemical reaction produced within the chromic acid couple being always the same, whatever may be the nature of the positive electrode, I have endeavoured to determine approximately by means of electrolysis, what voltaic energy (electromotive force) is capable of being transmitted to the circuit by this couple, according to whether its positive electrode is of platinum, carbon, or spongy platinum.

I obtained the following results:—

(*a*) The chromic acid couple, which I have already described, *i.e.*, with a positive electrode of platinum, produces a voltaic energy capable of being transmitted to the circuit of 1·4 volts only, or 65·5 calories.

(*b*) By substituting for platinum in the same couple, carbon or spongy platinum, we can get about 85 calories (1·8 volts) transmissible to the circuit, or 20 calories (0·43 volt) more than the preceding couple.

What I have just said with regard to the electrolysis of water, applies equally well to the decomposition of saline solutions by the electric current.

I found, in fact, that two couples formed of zinc-platinum and dilute sulphuric acid connected in series do not decompose a solution of sulphate of potassium.

Now, by employing two couples formed of zinc-carbon and dilute sulphuric acid, it is easy to decompose a solution of sulphate of potassium with liberation of gas at the two poles, and the transfer of the acid to the positive electrode and of the base to the negative electrode.†

The two experiments that I have just described prove indisputably that the transformation of thermo-chemical into voltaic energy (electromotive force) is more complete with a positive electrode of carbon than with one of platinum.

From what I have just explained, it follows that in every battery element the thermo-chemical energy generated by the soluble electrode (the zinc, for instance) would be transformed into voltaic energy by the unattackable body (carbon or platinum) that constitutes the positive electrode.

This transformation of thermo-chemical energy into voltaic energy by the positive electrode would be total or partial, according to the nature and the physical condition of the positive electrode.

It might happen, also, that the carbon would act as a true transformer, after the manner of an induction coil, and like it convert the parallel current into a series current.

If this were so, the augmentation of the electromotive force due to the substitution of the carbon for the platinum in certain voltaic couples would be obtained at the expense of their respective capacities. In other words, if the constants of a voltaic couple are, say, 2 amperes and 1 volt or 2 watts, and if, through the substitution of carbon for platinum the electromotive force increases so as to attain to 1·5 volts, the capacity must consequently decrease to 1·33 amperes, as 1·5 volts × 1·33 amperes = 2 watts.

We notice a still stranger fact with a couple formed of magnesium platinum and dilute sulphuric acid.‡

This couple should, in fact, according to the thermic data, decompose water, for the heat given off by the action of the magnesium on the dilute sulphuric acid is greater than the heat absorbed by the decomposition of the water. In short—

112·4 calories § >69 calories ‖.

However, as I have already stated, the decomposition did not take place.¶

It does not alter the case if we substitute for the platinum of the magnesium battery copper or silver. But if we use in this element as a positive electrode a cylinder of graphite or of retort carbon, the electrolysis of the water takes place.

According to Gore,* the electromotive force of the couple formed of magnesium-platinum and dilute sulphuric acid is 1·92 volts corresponding to 85·3 calories, and is consequently far above the heat of decomposition of water (69 calories), and yet, as has just been seen, the water is not decomposed.

Now, it has always been admitted that there is a correspondence between the voltaic energy transmissible to the circuit and the electromotive force of a battery element; in other words, that if the electromotive force of a couple is equal to 1 volt, for instance, this couple can produce the electrolysis of any compound whatever, the heat of decomposition of which is below 46 calories, corresponding to 1 volt.

Then how does it happen that there is an exception to this rule in the case of a magnesium couple? I shall shortly return to this important problem, the solution of which will not only furnish a more satisfactory explanation of the physico-chemical phenomena that occur in voltaic couples, but will also show us the true *rôle* that is played by the nature of the positive electrode, in the transformation of the thermo-chemical energy generated by the attackable metal into voltaic energy, or electromotive force, transmissible to the circuit, and capable alone of provoking chemical decomposition.

* Voltameter (an apparatus used for the electrolysis of water) must not be confounded with voltmeter (a measuring instrument).

† The electromotive force necessary to decompose sulphate of potassium in solution has been found to be about 103 calories. In fact, there is no electrolysis under the influence of voltaic systems equivalent to 76 calories (1·65 volts), or even 98 calories (2 volts). On the contrary, there is electrolysis, with liberation of gas at the two poles, with systems equivalent to 115 calories (2·5 volts), or even 103 calories (2·24 volts). See "Traité d'Electro-chimie," by D. Tommasi, p. 590.

‡ This couple consists of a magnesium wire and a platinum wire, both immersed in dilute sulphuric acid.

§ The heat given off by the action of the magnesium on the dilute sulphuric acid.

‖ The heat of decomposition of water.

¶ The true electrolysis must not be confounded with the *pseudo-electrolysis*, *i.e.*, the separation effected by the current of the only products resulting from the dissociation of the electrolyte. Thus, to give one example, with a dilute solution of chloride of ammonium we can, by the aid of a current, the electromotive force of which is less than the electromotive force required for the decomposition of the salt, observe an appreciable transfer of ammonia to the negative pole, and of hydrochloric acid to the other pole. But, in this case, it is not true electrolysis that has been effected, but pseudo-electrolysis, as the current has only separated the sole products of the dissociation of the chloride of ammonium in solution. What I have said with regard to chloride of ammonium applies equally to the decomposition of most salts, such as, for instance, sulphate of potassium, acetate of sodium, the cyanides, the formates, &c. It is the same with the decomposition of water, effected with a current, the electromotive force of which is much less than 1·5 volts ($\frac{1}{100}$ of a volt, for instance). (For further details, see "Traité d'Electro-chimie," by D. Tommasi, p. 31.)

ROYAL COMMISSION ON LONDON TRAFFIC.

SIR DAVID BARBOUR presided over a further sitting of the above Commission on Thursday last week.

Sir DOUGLAS FOX, past president of the I.C.E., M.I.M.E., M.I.E.E., said that with the late Mr. J. H. Greathead, he was engineer in chief of the Liverpool Overhead Electric Railway. He was engineer of the Great Northern and City Railway, now nearly completed; engineer, with Mr. W. R. Galbraith, of the Charing Cross, Euston and Hampstead Railway; and engineer, with Sir B. Baker, of the North-West London Railway, authorised but not yet commenced. He had also been associated with a number of other tube schemes which were now suspended. He had given much attention to the question of metropolitan traffic, and was well acquainted with what had been done in Boston, New York, Paris and Berlin. In dealing with the traffic of London he was of opinion that regard must be had to the necessity, on the one hand, of providing facilities for through passenger traffic passing over considerable distances, and on the other hand, for local traffic involving a transit of from half a mile upwards. The latter traffic, he considered would always be most effectively dealt with by motor omnibuses and electric tramways running generally on the surface of the streets, but in some very congested parts of the metropolis, possibly in shallow subways, if costly things of this kind could possibly be entertained. With the railways already authorised or completed, there would exist in London a very comprehensive network of "surface, underground and tubular railways," which had already been described by previous witnesses. While the authorised tramways within the same area would represent an important further provision, the electrification of the Metropolitan and Metropolitan District Railways would not only greatly increase the speed of the trains, but would, in consequence, largely add to their carrying capacity. Proceeding to deal with further tube railways required, Witness said the district most urgently in need was the North-East, including Stoke Newington, Tottenham, Leyton and Walthamstow. He would also like to see an extension of the North-West London Railway from the Marble Arch to Victoria, whilst a line from the Sloane Square Station of the Great Northern, Piccadilly and Brompton Railway to Clapham Junction would give great facilities in the south-west; extensions to South London should probably be overhead, as the strata were not favourable for tunnelling. He had carefully considered the question of shallow subways for tramways, and believed that whilst they were practical and feasible in new streets, their cost in old main thoroughfares, such as Piccadilly, the Strand, Gracechurch Street or Bishopsgate Street, would be found prohibitive. With regard to Mr. Fitzmaurice's evidence as to a shallow tramway from Bishopsgate along Kingsland Road, Witness felt that it was feasible, but the cost was prohibitive. In his opinion the only practicable way in which the access to the heart of the City could be obained from Walthamstow and Tottenham districts was by tube. The secret of the success of the tubes had been the placing of the tube in London clay below the made ground and water-bearing strata which overlies the clay. The damage done to St. Paul's Cathedral by the construction of a sewer in the gravel showed plainly what would be the effect of the pumping which would be necessary in constructing subways under the surface where shields could not be used. He had hitherto advocated a slightly larger diameter for tubes than that now adopted by all the lines, with the exception of the Great Northern and City Railway. The advantages of the increased diameter were that the use of more powerful motors was possible, permitting increased acceleration, and there were better facilities for ventilation, but the financiers who controlled the authorised railways had apparently decided that it would not pay to go beyond 11 ft. 6 in. net diameter. The serious accident on the Paris Metropolitan Railway had resulted from electrical arrangements which were being avoided in London, where every precaution was being taken on the lines under construction against fire, and to secure the lighting of

* See "Traité des Piles Electriques," by D. Tommasi, p. 149 and the "Formulaire Physico-Chimique," by D. Tommasi, p. 375.

tunnels and stations in case of accident, so as to afford ready means of escape for passengers. He considered that many of the clauses insisted upon in tube Bills were of excessive stringency and involved unnecessary cost and delay in carrying out the works. He desired to give emphatic expression to the view that capital could not be provided for carrying on tube railways if the Acts authorising them were to be burdened with onerous conditions, and he felt that in agreeing last year to 2d. fares for certain distances and for workmen's return tickets at half-price, which meant about ½d. per mile, which were to be available for arrival at a destination not later than 8 a.m., the promoters carried concession to its utmost limit. Such a clause as the London County Council would agree to, giving them the right to purchase, could not be entertained without destroying the prospect of raising the capital. The same observation applied to proposed clauses making it compulsory on tube railway companies to apply to Parliament from time to time for power to make at their own expense, subways not suggested or capable of being indicated when the Acts were passed and subscriptions for capital obtained, to clauses limiting dividend, and to clauses making companies liable to have their authorised charges and fares reduced arbitrarily below the rates fixed by their Act. Provisions of this kind made it impossible for the investor to calculate on his return. He strongly urged that physical junctions should be absolutely prohibited on those parts of lines which ran through the heart of the city. The two serious objections to the procedure in the case of Tramways Provisional Orders were that no compulsory powers could be given for taking property, and that the terms of purchase were so severe upon a company as to render it difficult for intending promoters to raise the capital. He did not think that the provisions of this Act could be at all conveniently applied to any extension of facilities in London except possibly by the London County Council. Every facility was given by the Light Railway Commissioners, and so far as their procedure was concerned, both economy and a saving of time were effected. These advantages, however, were largely discounted by the fact that an allegation of serious competition with existing railway companies was, *ipso facto*, fatal to an application, and that while they had authority to grant compulsory powers for land and property, the Commissioners could not suspend or modify Sec. 92 of the Land Clauses Act, thus often rendering the cost of widenings prohibitive where only forecourts were required but the whole property must be taken. He had had 35 years' experience of the Committee Room in regard to Private Bill procedure, and was of opinion that as a rule substantial justice was done. At the same time the requirements of standing orders were very onerous, the fees were high, and the double inquiry before the Committee of each House involved double expense. Quite late, especially with reference to tube Bills, the practice had arisen in Parliamentary Committees of asking for something nearly approaching an absolute guarantee of the capital. This practice originated in 1902, at the time of the great competition between two American houses and the Central London Railway for the Parliamentary rights of underground communication between Hammersmith and the City, when Sir Clinton Dawkins on behalf of Messrs. J. S. Morgan & Co., and the representative of Messrs. Speyer, guaranteed the capital. If this policy was to be continued, a very serious obstacle would be placed in the way of increased facilities. The effect must be to give a monopoly of further extension either to large existing companies or to one or two powerful groups. He considered that a tribunal dealing with Bills for works in the Metropolis, should be well satisfied as to the *bona fides* of the promotion, should see that the capital was neither deficient nor unduly inflated; and that the 5 per cent. deposit was fully secured for the protection of the public and property owners. The City and North-East Suburban Railway Bill was thrown out solely on the question of finance, inasmuch as the financial evidence adduced did not assume the form of a guarantee of the capital. The chief objection to the present Parliamentary system was that there was no comprehensive programme; that often in the same session, works affecting London were dealt with by different committees, and that there was no continuity of policy underlying the decisions. He was strongly in favour of establishing a new permanent tribunal, say, of five members, who, with the exception perhaps of the chairman, should be required to give exclusive attention to their duties. The chairman should be a man of well-known high character and of judicial capacity, and with him might be associated a barrister of Parliamentary experience, a civil engineer of railway, tramway and Parliamentary experience, a representative of the municipal authorities, and a representative of the Board of Trade. The tribunal should for its own guidance, and not necessarily for publication, give preliminary consideration to the existing means of communication, and to the probable requirements of the future, and should as far as possible adhere to a fixed policy with reference to its mode of dealing with the proposals brought before it. It should have full power to call witnesses before it, and to grant compulsory powers for properties where shown upon deposited plans. It should hold public inquiries at which all persons who had interest for or against should be freely heard, either personally or by counsel. The tribunal should have power to award costs either against promoters or opponents where it considered the promotion of the opposition to be frivolous. The tribunal should have power to insert such conditions as it might think desirable, both as to the amount of deposit money to be paid and the time thereof, the amount of share capital or borrowing powers and the dates of the commencement and completion of works. With such a tribunal, there would be no necessity for a right of appeal to the Board of Trade or other State department, but all orders, before becoming law, should be reported to Parliament. In case of opposition, it would be very desirable that their fate should rest with a Joint Committee of the two Houses. The clauses which had lately been introduced into tube Bills, giving the Board of Trade a more complete control, and extending the protection of landowners against damage to two years after opening were valuable, and should become standard clauses. A certain amount of municipal control over surface work or works interfering with sewers was right, but there had been a tendency lately to overload Bills with provisions of this kind, and it was highly desirable that the mutual relations of the County Council, the Corporation and the Borough Councils should be defined, so that companies should not be subjected to delay, and often to opposing control.

On Friday, Mr. A. C. MORTON, chairman of the Streets Committee of the City Corporation, put forward the views which his Committee had arrived at with regard to the establishment of a tribunal to deal with all questions of London locomotion. It was considered that the members of the tribunal should be paid and should devote their whole time to the work. They should consider the schemes presented to them, and report from time to time on the subject of the traffic and locomotion in London generally, but should not have power to direct improvements to be carried out. They should report on local improvements required and on locomotion generally. The tribunal should not be responsible for the supervision of works. All tramway schemes should be settled by the tribunal, subject to the rights of local authorities; the tribunal should have the power to confer compulsory powers in regard to the acquisition of property upon promoters of schemes. They should have power to compel existing companies to carry out new works, after hearing all parties interested who should have the right to be represented in the manner they thought best. The powers of the tribunal should be retrospective, and they should, as far as possible, have a settled policy of action, so as to ensure continuity of principle. The road authorities should have complete control in regard to the opening of streets in their respective districts. The tribunal should have the power to apportion the cost of improvements according to the advantages derived from the same in districts contiguous to those in which improvements were effected. The tribunal should settle all questions in dispute between local authorities and companies and promoters of schemes of proposed improvements or for facilitating locomotion.

Alderman Sir HENRY EDMUND KNIGHT, the next witness, said that, in his opinion, among the main causes of obstruction were "concentration of traffic to centres," heavy goods traffic, and tramways. Cross-roads were also a fruitful source of congestion, but this might be overcome by the construction of suspension bridges at such points as Ludgate Circus and Oxford Circus. Dealing with the question of heavy goods traffic, witness put forward a suggestion that two zones, or ellipses of underground electric railway, one a mile north and south of the river, and the other a mile further out, should be constructed. All railway companies bringing goods into London should be compelled to make connections between the railways and their goods stations. Large establishments might be accommodated with a siding to themselves, the goods being brought up by lifts. There should also be sidings at the docks, and all great centres. If carried out, the scheme would involve the construction of 40 miles of line. The tubes should be capable of taking the ordinary railway stock. Goods that could not be conveyed underground should be carried by motor traction. Speaking on the question of tramways, he said that, in his opinion, they were of great public utility where the streets were wide, but they would be impracticable in the City, and ought not to be allowed in any town unless the lines could be laid 20 ft. from the kerb. Even if trams were allowed over the bridges, and he was strongly opposed to that, they would be of little service owing to the congested state of the City streets.

INSTITUTION OF ELECTRICAL ENGINEERS

ELECTRIC TRACTION WITH ALTERNATING CURRENTS.

By A. C. EBORALL, Member.

(*Paper read at Manchester, December 15th*, 1903.)

(*Continued from page 77.*)

IN order to get anything like good results with tandem parallel control, the power factor of the secondary motors must be very high—considerably above 90 per cent. In practice (apart from the employment of compensating arrangements) this means that the number of poles in the motors must be as small as possible, as, considering the relatively small diameter of the motors, it would not be possible to get power factors of this order if they had many poles. It would appear that six, or, at the most, eight poles is about the limit for motors which have to work in tandem, which corresponds to frequencies lying between 15 and 25 cycles, the lower values being taken for gearless, the higher for geared motors, taking into account the usual maximum running speeds, wheel diameters, &c.

The other disadvantages possessed by the tandem parallel control may be said to be of a mechanical nature; their extent depends upon the manner in which the method is employed. If, for instance, all the motors are utilised during the period of parallel connection, they must all be alike, which means that, when in tandem, separate rotor resistances will have to be used for the secondary motors, and these will have to be designed for the same pressure as that of the line. For instance, with a four-motor 3,000-volt equipment, four separate resistances would be necessary, namely, two suitable for 3,000 volts, and two double ones for (for instance) 300 volts and heavy currents. Bearing in mind that if the same torque is required in tandem as in parallel,

the flux in the stators of the primary motors will have to be increased, as already indicated, it will be seen that the equipment becomes not only excessively complicated, but very expensive as well.

If, however, the Valtellina arrangement is adopted, matters become greatly simplified; no high-pressure resistances are required, and the two rotor resistances are employed alternately for the secondary and primary motors. Further, no boosting or other special arrangements are required for increasing the torque of the motors in tandem. But it must be admitted that the fact of half the motors being idle most of the time constitutes a certain disadvantage; clearly, on a fairly level line with infrequent stops, the carrying round of so much dead weight would not be warranted. Again, it follows that, with this arrangement, the primary motors must work when in parallel well below the point of maximum load, in order that over-heating may be prevented, and, generally, such an equipment is altogether rather expensive.

Whichever form of tandem multiple control is employed the motorman has in general to operate two controller handles which are not interlocked, as it is not possible to pass directly from the parallel connection to the off position through the tandem position, in an analogous manner to the handling of a series-parallel controller.

The commercial application of tandem parallel control in any form to multiple unit trains with two or more motor cars would be difficult, if not impossible. It is, of course, perfectly possible with rheostatic control of the motors, and hence for those cases in which such trains are required, worked by three-phase motors, the system of control used would be in general decided by this point quite apart from other considerations. In connection with the operation of mechanically connected induction motors for such work, it is of importance to see that the difference in diameter of the various pairs of driving wheels is as small as possible, in order that the individual motors may properly share the load when operating at full speed on the level. Otherwise, as a little consideration will show, owing to the small slip under these conditions, the slower running motor might get badly overloaded. A comparatively small difference in the speeds would transfer the load to one motor, the other even acting as generator, being driven by the first.

Table II. and fig. 7 may fittingly conclude these remarks on the subject of speed control. A comparison is given in the table between the starting performance of direct current and three-phase equipments, as determined by actual trials. To extend the comparison, certain figures relative to the trials of a steam locomotive are also given. Regarding the relative performance of the electric equipments, it must be pointed out that the comparison is not altogether a fair one to the three-phase motors, but it is the best that could be made, based upon actual tests. The two equipments are working under different conditions, and, moreover, the three-phase motors were not designed for such rapid accelerations as those in the direct current cases. In the latter it is pretty clear that the series-parallel control was worked for all it was worth. In fig. 7, however (for which the author is indebted to Mr. Blathy), the results are embodied of a special test made by Mr. Kapp on the Valtellina Railway, for the express purpose of seeing what results could be obtained by the use of the tandem parallel control in the form advocated by Messrs. Ganz & Co.

An inspection of the curves in fig. 7 shows that the electrical performance of the equipment leaves little to be desired. The 54-ton train attained a speed of 59 ft. per second in 95 seconds, which corresponds to an average acceleration of 0·62 ft. per second per second, the acceleration with the two pairs of motors in tandem being about 1½ ft. per second per second, while with the two primary motors in parallel it is about ⅔ of a ft. per second per second. These are excellent results, while at the same time, partly on account of the energy returned to the line during the retardation period, the results with regard to power consumption are excellent, as will be seen from the following summary of this particular test made by Mr Kapp:—

Test No. 5 (see fig 7).

Distance covered	5,280 ft.
Time from start to finish	140 seconds.
Highest velocity attained before braking ...	40·5 miles per hour.
Electrical energy supplied to car	20,574 KW.-seconds
Energy consumption per ton-mile	106 watt-hours.
Useful energy up to the moment (106 seconds from start) when brake was put on by the motors being switched in tandem	14,300 KW.-seconds.
Total energy supplied in the same time ...	21,960 KW.-seconds.
Efficiency during the above period	65 per cent.

The high efficiency of 65 per cent. is partly accounted for by the fact that at the end of the period in tandem, when the load is quickly falling, the generating plant increased its speed, enabling the rotor resistances to be short-circuited during a portion of the time, from 29·5 to 32·7 ft. per second. On the other hand, when braking in tandem, the generating plant also increased its speed, being driven by the current returned from the car, and thus the frequency went up. This did not enable the car to return as much energy as would have been the case at constant frequency, and accounts for the smallness of the energy (1,386 KW.-seconds) returned to the line.

From Table II. and fig. 7 it will be seen that, on the whole, the figures for the three-phase equipments are excellent, but with rheostatic control they would not compare so favourably with the direct current equipments at the higher accelerations; with tandem parallel control, while there is little to choose between the two equipments, the good performance of the three-phase equipment is attained at the expense of the disadvantages which have already been referred to.

From what has already been said it is clear that with regard to which is the better system of control for three-phase equipments, the rheostatic or the tandem parallel, this depends to a great extent upon the class of work for which the equipments are employed. But the author thinks, in the present state of knowledge, that the use of alternating currents should only be contemplated for work of the class comprised under (*c*) and (*d*), and then only when the length of the lines is such that many converting sub-stations are necessary. For these classes of work, the inefficiency of the rheostatic control is of relatively small importance, and it is thought that its use is preferable, notwithstanding the disadvantage of hav-

TABLE II.—COMPARISON OF ACCELERATION AND POWER CONSUMPTION TESTS CARRIED OUT WITH DIRECT CURRENT AND THREE-PHASE ELECTRICAL EQUIPMENTS.

Installation.	Nature of supply.	Total weight of train in tons.	Maximum speed in miles per hour.	Normal rating of motors in B.H.P.	Average acceleration (feet per second per second).	Average watts per ton during acceleration period.	Watt hours per ton-mile during acceleration period.	Watt hours per ton-mile during acceleration and retardation period.	Remarks.
1. G. E. Trials (Schenectady)	Direct current at 575 volts.	71·5	47	8 × 165	0·95	6,500	170	129	Each of the eight motors employed is rated at 3,000 lbs. pull at 23 miles per hour and with 280 amperes. Average speeds 34·6 and 32 miles per hour respectively. Two motor cars with four motors per car.
2. Ditto.	Ditto.	118·5	43	8 × 165	0·79	4 650	133	99	
3. Liverpool Overhead Railway.	Direct current at 500 volts.	46·3	32	4 × 100	0·88	4,000	170	137	Two motor cars with two motors per car, each rated at 2,000 lbs. at 25 miles per hour and 160 amperes.
4. Burgdorf-Thun Railway.	Three-phase current at 750 volts and 40 cycles.	70·0	24·5	4 × 65	0·46	2,570	195	—	Rheostatic control. Full load speed of motors 585 revolutions. Gear ratio 1:2·96; driving wheels, 40 in.; weight of complete motor, 3 400 lbs.
5. Ditto	Ditto	55·0	24·5	4 × 65	0 63	3,450	240	—	
6. Valtellina Railway	Three-phase at 3,000 volts and 15 cycles.	82·5	40	4 × 150 (two motors idle above ½ speed.)	0·38	2,770	—	65	Drawbar pull per gearless motor with 46-in. wheels at 330 revolutions = 2,200 lbs. Pull at starting in tandem with idle motor 3,960 lbs. per pair of motors.
7. New York Central Steam Locomotive trials.	—	130·0	51	Drawbar pull = 25,900 lbs.	0·86	—	—	—	Locomotive specially built to meet requirements of suburban traffic.

NOTES:—On the Valtellina Railway, the four motors are connected in tandem up to half speed, while from half speed to full speed two are idle, the other two being in parallel; when braking, the four motors are in tandem from full speed to half speed. The author is indebted to Mr. H. F. Parshall for the above test figures; the watt hours during acceleration were 10,200, and during braking 1,300, the total distance of 1·66 miles being traversed in 240 seconds.
All the above tests were carried out on the level.

ing to take the worst gradients at full speed. If, however, for any reason, three-phase working is employed for cases where it is necessary to attain rapid accelerations with economy, the tandem parallel system of control must be used, and of the two forms in which it can be applied, that advocated by Messrs. Ganz is, it is thought, preferable on account of its greater simplicity, this point outweighing the disadvantage of the exceedingly heavy character of the electrical equipment.

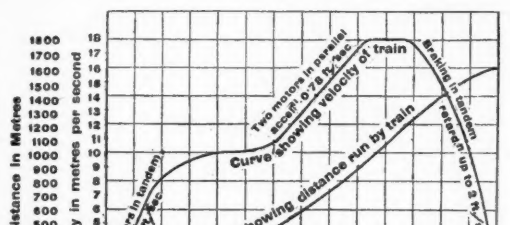
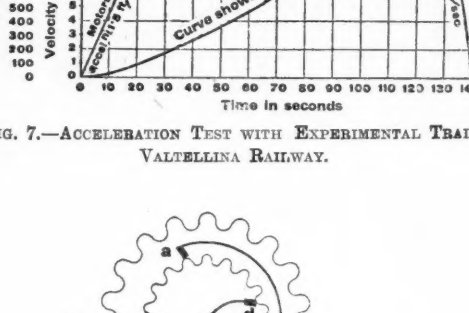

Distance in Metres
Velocity in metres per second
Time in seconds
Motors in tandem accel. m/s ½ sec.
Two motors in parallel accel. 0·78 m/sec.
Curve showing velocity of train
Braking in tandem retarding up to 3 m/sec
Curve showing distance run by train

FIG. 7.—ACCELERATION TEST WITH EXPERIMENTAL TRAIN, VALTELLINA RAILWAY.



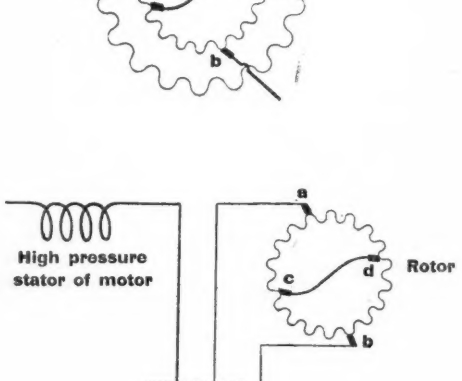


FIG. 8 (A) AND (B).—DIAGRAMMATIC REPRESENTATIONS OF LATOUR AND WINTER-EICHBERG SINGLE-PHASE REPULSION-SERIES RAILWAY MOTORS.

However, an attempt has been made to put forward the characteristic features of each method of control, and to dwell rather upon the weak points of each, as whichever method is selected in any particular case, these are the points that require the most attention.

SINGLE-PHASE WORKING.

The desirability of single-phase working for long-distance lines is self-evident, assuming that suitable motors are available. As the whole question turns upon the motors, it is now proposed to consider very briefly the various types of single-phase motors at present available. These types, apart from synchronous motors, are as follows:—

1. Pure induction motors.
2. Series motors (Lamme, Finzi).
3. Repulsion-induction motors (E. Arnold, Deri, Schüler).
4. Repulsion series motors (Latour, Eichberg-Winter).

The first mentioned class of single-phase motors can be dismissed in a few words, as they cannot be directly applied to electric traction purposes. Their efficiency and power factor are less than is the case with the corresponding three-phase motors, their speed cannot be regulated within commercial limits, their overload capacity is relatively small, and their starting performance is indifferent. The best that can be done in the latter respect, under favourable conditions with regard to frequency, is full load torque with 1½ full load current—this with the help of a rotor resistance and a phase splitting arrangement. Such motors could therefore only be used indirectly as far as electric traction work is concerned, although they possess the advantage (unlike the motors of the other three classes) of being without commutators.

B. J. Arnold has proposed to utilise such motors for traction purposes, with the help of an air-compressor on the car, the object of the latter being to get over the starting difficulties as well as those of speed regulation. The motor is always running on load, this consisting of the car and the compressor, or the latter alone, as the case may be. The Oerlikon Co., on the other hand, has suggested the use of single-phase induction motors in connection with heavy locomotive work, the motor working from a single overhead conductor at 15,000 volts, and forming part of a direct current motor-generator combination carried by the locomotive, which supplies current to separately excited direct current motors on the car axles. Although a certain amount of experimental work has been done in connection with each of these suggestions, it is hardly likely that such methods of working will come into general use.

The single-phase motors comprised in the second class are what used to be known a good many years ago as "laminated field" motors; before the advent of the single-phase induction motor quite a number were built in this country for the 83 and 100-cycle supply circuits then in existence. At that time they were built in very nearly the same way as the corresponding direct current series motors, the principal difference in the design being the substitution of a laminated field structure for the standard cast or wrought-iron field frame. Such motors possessed every fault it is possible for a commutator motor to have—low efficiency, overheating, and bad sparking being the worst—while being abnormally heavy for their output, mainly on account of their very lower power factor.

After remaining in the background practically since 1893 these motors have recently reappeared as possible railway motors. By reducing the frequency to 15-20 cycles (and with the help of sundry auxiliary devices which have been more or less well-known for years), aided by careful designing, a very good imitation of the direct current series motor has been obtained, which is likely to come to the front in the future. Up to the present by far the best results have been attained with these series motors by Dr. Finzi, the trials of whose 15-cycle 160-volt tramway motor are fully dealt with in an article in the ELECTRICAL REVIEW for November 13th, 1903.

The following are the principal difficulties connected with the design of single-phase series motors, together with the methods which are adopted in order to get over them:—

1. *Sparking.*—The coils, which are short-circuited as the commutator segments, to which they are connected, pass under a brush, become the seat of very heavy induced currents, as these coils are cut by the alternating field flux. These heavy, short-circuit currents, being interrupted when the segments leave the brushes, cause heavy sparking; moreover, they tend to demagnetise the field system, and also waste energy in the short-circuited coils, brushes, &c.

The remedy is to connect the armature coils to the commutator by means of nickeline or other resistance strips (Finzi), or to employ a Weston winding on the armature (two independent windings alternately in circuit), to employ the proper width and quality of brush, and to reduce the frequency.

2. *Relatively Low Efficiency.*—This is due to the fact that both the iron and copper losses are considerably more than in the corresponding direct current motor or induction motor. In the latter, not much more than half the total weight of laminated iron is traversed by a flux of the full frequency (at speeds near synchronism), while for the case of the series motor the entire weight of active iron comes into consideration. Again, owing to the extra losses in the commutator connections, brushes, &c., and to the rather low power factor at heavy currents, the copper losses are increased.

A reduction in the frequency improves matters.

(To be concluded.)

Abstract of the Discussion on Mr. P. V. McMahon's Paper (read in London) on "Working Results on the City and South London Railway."

PROF. A. CARUS-WILSON drew attention to the method of connecting the two tracks in series with 1,000 volts between them; this, he was considered, a unique feature. It was absolutely necessary to use the rails for a return conductor, and he considered that this largely increased the risks of short circuits. If a double insulated conductor rail had been used the risks of earths and short circuits would have been greatly minimised, and for this reason he thought the double insulated conductor had important claims to consideration. He explained that the reason why no serious accident had arisen in working the City and South London system, was that that company could only use locomotives, and in the latter all the electrical apparatus was collected together and isolated from the rest of the train. He attributed the Paris and Liverpool accidents to the system of motor-cars and track returns adopted on these lines. In the case of the Central London Railway, the motor-cars now used were really locomotives joined to cars, one being used at each end of the train. He considered that multiple unit systems, such as will be adopted on the Metropolitan, District, and Great Northern and City lines, were very liable to short-circuits, and in those cases insulated return rails were a necessity. He urged that they must take every opportunity of minimising risks.

Mr. H. M. HOBART complimented Mr. McMahon on the excellent results which he obtained from his somewhat motley collection of plant, and he agreed with the last speaker as to the unique features of the system. He presumed that Mr. McMahon would not follow the same arrangement if he had to start afresh; he was sceptical as to the efficiency of a system employing so many auxiliary motor balancers, reducers and multipliers, and thought that too much battery power was provided. In place of the latter he preferred to put in more generating plant. Batteries were costly, both as to price

and maintenance and not efficient. He suggested that it would be better to use 2,000 volts between the outers, and employ 1,000-volt generators and motors. With low speeds these machines in large sizes were quite practical for traction work. The advocates of polyphase railway systems were rapidly getting into difficulties and reverting to the continuous-current system.

Mr. BJORNSTAD said a great deal in an inaudible tone on the subject of lifts. He thought the difficulty of accurately stopping the lifts was due to a difference in the speed, from that originally intended. The wear on the ropes was due to too small guide pulleys and to the employment of S drives.

Mr. J. S. HIGHFIELD was of opinion that Mr. McMahon's system of feeding the railway had not been properly appreciated. As recorded in the paper, the system of reducers involved the transformation of only half the energy at each sub-station—the reducers were only half the capacity which would be required in motor-generator plant for the same purpose, and therefore half the cost. He questioned whether the sub-station efficiency had been equalled on any other railway. He justified the use of a battery situated at a distance from the generating station, as it displaced a certain amount of plant in the latter, and actually cost less per KW, if feeder and converting plant were included. He didn't consider it worth putting in a battery unless an efficiency of 80 per cent. could be obtained, and in estimating the efficiency, the improved efficiency of the feeder system should be taken into account. Referring to Prof. Carus-Wilson's remarks on insulated and earthed return conductors, he pointed out that the reason why an insulated return was used on the Mersey and Liverpool Overhead Railways was because it was found cheaper to have a large voltage drop in the return, than to comply with the Board of Trade regulations, restricting that drop to 7 volts. Another advantage of the insulated return was that it could be used as a positive rail in an emergency. He commented on the fact that a lighting station cannot obtain as low costs on the same load factor as a traction station. In the latter, the boilers appeared to be worked under better conditions—they had a more even load to deal with. He considered that the steady voltage conditions were largely due to good governing on the engines and efficient compounding of the generators.

Mr. J. N. SHOOLBRED emphasised the advantages of employing only one class of plant (*i.e.*, direct current) in connection with the line; the employment of batteries had proved very satisfactory.

Mr. T. STEVENS, commenting on the arrangement of the connections to the working conductor sections, observed a similarity to the conditions present at the Paris fire. He considered that the Paris railway had copied the author in providing for lifting the shoes, and in Paris the various sections were controlled by cut-outs; he thought there appeared to be considerable difficulty in designing a circuit-breaker to open a feeder in circuit, as recommended by the Paris Committee of Investigation. The recommendations as to insulated return rails were opposed to the conclusions to be drawn from the recent bath accident in South Africa, and he considered it better to have one side of the system earthed. In the case of the Central London Railway at Shepherd's Bush, the middle of the star connection of the alternators was earthed, also the transformer cases. He did not see how to avoid using cable connections between the shoes and under the cars, and he had never heard of an accident arising from this cause.

Mr. W. H. BOOTH criticised the coal consumption of 3½ lbs. per KW.-hour, and instanced a case where 2·3 lbs. per I.H.P., or 3·5 lbs. per KW. had been obtained with a rather ancient mill engine, using steam at 60 lbs. pressure, as against 160 lbs. at the Stockwell generating station. He questioned the reliability of the tests for wetness of the steam, and advocated the desirability of superheating, the amount of which could be measured at once by a thermometer. He did not consider it fair to compare high and low-speed engines using wet steam, the former being much the worse in the matter of condensation under these conditions. In fact, Mr. Booth appeared to regard the results as showing very good hot-water engineering, but hardly creditable steam engineering.

Mr. H. JONES considered the position of the generating station a drawback, conveyance of coal and stores being a heavy item. He had (on the Waterloo and City line) a Kennedy water meter on his pump suction, and considered it accurate enough for ordinary use. He commented on the economy in using motor-driven auxiliaries, and touched briefly on the necessity of good bonding at the rail joints. The following results were obtained on the Waterloo and City line for the six months ending June, 1902:—Units generated, 3,781,000; coal consumption, 3·9 lbs. per unit. For the six months ending December, 1902, units generated, 5,000,000; coal per unit, 5·6 lbs. The figure for the coal per unit was ·53d., as against ·31d. on the City and South London Railway; the item for oil, was, however, lower, possibly due to the use of high speed engines; wages were five times as high, and the total cost per unit for the half-year was 1d. He estimated from the figures given by the author that the units per loco. ton-mile measured at the switchboard were ·0608; on the Waterloo and City, this figure was ·0552. The coal per ton-mile was ·313, as compared with ·237 given in the paper, and the station load varied from 150 to 1,050 amperes. The time lost through loco. breakdowns on the Waterloo and City during the year amounted to only ·135 per cent., and from electrical causes amounted to less than 3 minutes per week.

Mr. E. V. CLARK, while favouring the Corliss engine, thought the author hardly fair in his comparisons between that type and the Willans; the former were working at their test load and the latter with an overload. In regard to electrical *v.* hydraulic lifts, if the capital charges were added in each case, he considered that electric lifts would come out unfavourably in comparison. The Central London Railway were replacing their electric lifts by hydraulic ones. He suggested that more economical working would have resulted had double wound generators, with a double size engine been adopted at the generating station, and criticised the ability (from the diagrams given by the author) of the Highfield booster arrangement to keep pace with the load.

Mr. H. M. SAYERS remarked that the author had grasped the necessity of considering economy of distribution and generation together, and thought that he had excelled any three-phase system in the matter of power costs on the loco. He thought that all railway problems must be considered on their merits, and the author had shown what could be done with a low tension system. In regard to Prof. Carus-Wilson's objections to the earthed return, he thought he overlooked one danger while watching another, as it was exceedingly desirable, in the interests of safety, to know what potential you were working at. There was no difficulty in arranging an insulated rail, to be earthed at the generating station, but the neglect of earthing led to the possibility of excessive voltages in the positive conductor.

Mr. J. W. BROWN, speaking on the question of lifts, stated that on the Central London Railway the estimates for the hydraulic lifts were less than for electrical ones, and this was generally so, for lifts of less than 170 ft. travel. The new Brighton tower lift (about 350 ft.) came out much cheaper electrically worked. He condemned the small pulleys and S drives, as being detrimental to the life of the ropes, and recommended a system combining electrical and hydraulic features as the best solution of the question. At the present time, however, hydraulic lifts were the best in actual working.

Mr. W. H. PATCHELL's experience in regard to engines coincided with Mr. McMahon's. One large engine with few cylinders gave better results in practice than three small engines of similar capacity with many cylinders, and too much importance was attached to the latter qualification. He agreed with Mr. Booth's remarks on calorimetry, and suggested that it was an easy method of thoroughly deceiving yourself. He thought that Mr. McMahon had a good condenser in his double steam-pipe ring; he also had the luxury of double stop valves. It would have been better, in his opinion, to have spent the spare cash in proper condensing plant. A single steam main was sufficiently reliable in the matter of pipe joints with modern construction. His experience of several 200-H.P. 1,000-volt motors was very satisfactory, but they didn't use 1,000 volts on the fields, as in traction work. He thought that crossed fields were preferable to compound fields on the balancers.

Mr. E. J. FOX, referring to the figures for coal consumption, stated that he had obtained results as low as 2·7 to 3 lbs. per KW. with coal at 5s. per ton; there was a considerable margin between the best done and the possible. He thought the Willans engine did not receive fair play in the paper; it was specially adapted for high steam pressures and superheats of at least 500°, and you couldn't use as much superheat on a Corliss engine. Taking into account the poor chances of the Willans engines, he thought the results were much in favour of the high-speed engine. Corliss engines were more costly than high-speed engines up to a certain size, and both types gave way to the turbine in large sizes. The figures for the Willans steam consumption, *i.e.*, 18·5 lbs. (in the paper), would be reduced to 11·7 lbs. per B.H.P., as compared with 16·3 lbs. (the Corliss steam consumption per B.H.P. given in the paper), if advantage were taken of high-steam pressure and superheat. In a comparison between high-speed and Corliss engine works costs, the item for labour and repairs in the two cases should be compared.

Mr. P. V. MCMAHON replying, stated that with an earthed return, a fault would be discovered without totally disabling the loco.—the advantages of the system as compared with others had been dealt with by previous speakers. The use of motor-car trains necessitated long examination pits, and fan-tail sidings, matters of considerable cost and not possible with his line. Their pits were on short sidings, and held one loco. In regard to Mr. Hobart's remarks, if he (Mr. McMahon) had the work to do again, he would adopt the same system, with slight modifications. The batteries had proved a valuable stand-bye in emergencies, for working lifts and station and tunnel lights. He agreed that doubling the voltages was quite feasible, but doubted whether the added efficiency, 1 to 1½ per cent. was worth the extra risks. He agreed with the speakers as to the cause of the lift ropes deteriorating, but considered that the electric lifts with long cable connections, would come out cheaper than hydraulic lifts and transmission. In point of working cost, 10 hydraulic equalled 25 electrical lifts, and given better controlling qualities, they were much more economical. With regard to Mr. Stevens's remarks, he had had switch fuses in each section since the line opened, also for emergencies, each loco. had a portable telephone instrument to fix on to bare telephone wires in the tunnel for calling up the nearest signal box. In regard to the coal consumption tests (which were taken by Mr. Morley, of Messrs. Cole, Marchent and Morley), coal conveyance had been added to the cost. They could not use motor-driven feed pumps, as there was no battery at the generating station. The rail bonds were of the Neptune type. He had had trouble through bonds not being flexible enough and breaking. In regard to Mr. Jones's figures (Waterloo and City Railway), they burnt Welsh coal, while on the City and South London Railway, North-country coal was used. The Waterloo and City figures for power per ton-mile were better, owing to its having one long section—acceleration at starting took half the energy used. In regard to time lost through breakdowns, during the last half-year this was reduced to ·05 per cent. for loco. failures only. As to the suggestion of double generators, they were inefficient at light loads, and would complicate the switchgear. The Highfield boosters were not called upon to do all the regulating, as the balancers do it. He defended the double steam main on the grounds of reliability, and thought that up to a certain size the Willans engines held their own in first cost, but in the larger sizes Corliss engines had advantages. There was little difference in the repairs in practice.

At the conclusion of the discussion, the President of the Institu-

tion, Mr. R. K. Gray, announced that the Council had decided to award Mr. McMahon the Willans premium, for the valuable paper which had been read to them.

NEW PATENTS APPLIED FOR, 1904.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

12. "Improvements in electric dynamos and motors." T. W. S. Hutchins. January 1st.

33. "Improvements in or relating to the trolley wires of electric tramways." G. Hall. January 1st.

97. "Electric car trolley-sheave guide for finding the current-conducting wire." J. Rose, T. Henwood and J. Squire. January 2nd.

107. "Improvements in high-tension electric generators." S. Evershed and Evershed & Vignoles, Ltd. January 2nd.

114. "Improvements in or relating to sparking plugs." P. Duflos. (Date applied for under Patents Act, 1901, January 7th, 1903, being date of application in France.) January 2nd. (Complete.)

121. "Improvements in gas or vapour electric apparatus." F. W. Le Tall. (The Cooper-Hewitt Electric Co., United States.) January 2nd.

181. "Improvements in and relating to the regulation of electric currents." P. Cour. (Date applied for under Patents Act, 1901, January 5th, 1903, being date of application in Denmark.) January 2nd. (Complete.)

185. "Improvements in and relating to alternating-current generators and motors." A. P. Zani. January 2nd.

187. "Improvements in and relating to alternating-current distribution system and apparatus therefor." W. B. Woodhouse. January 2nd.

157. "An improved method and means of electric traction." A. W. Murray. January 4th.

193. "Improvements in the equipment of electrically-propelled railway cars." Siemens Bros. & Co., Ltd. (Siemens & Halske Aktien-Gesellschaft, Germany.) January 4th. (Complete.)

214. "Improvements in electric batteries." P. J. Kampferdyk. January 4th.

232. "Improvements in or relating to the trolley wires of electric tramways." G. Hall. January 5th.

233. "An improved system for connections to switchboards, mains and electrical machinery and improvements in electrical switches." H. W. Clothier. January 5th.

238. "An improved auto-copying telegraph." A. C. Brown. January 5th.

266. "An electrical alarm for railway carriage and other doors." A. H. Stewart. January 5th.

291. "An improved electric incandescent lamp." C. C. Regnart. January 5th. (Complete.)

306. "Improved trembler for induction coils." F. C. Blake. January 5th.

319. "Improvements in electric cables." M. B. Field. January 6th.

341. "Improvements in the overhead equipment of electric tramways." C. Naylor and J. Naylor. January 6th.

351. "A safety device for use on vehicles propelled by electric traction on the stud-contact system." W. Griffiths and B. H. Bedell. January 6th.

359. "Improvements in or relating to electroscopes." T. Sewell. January 6th.

402. "Improvements in electric apparatus for therapeutic use." F. C. Fisher. January 7th.

429. "The electro-gyroscopic compass." C. V. Usborne. January 7th.

460. "Improvements in wireless telephony and in apparatus therefor." S. Lifschitz. January 7th.

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559. "Improvements in microphones for telephonic apparatus." L. T. Bassompierre and L. J. M. Dardeau. January 8th. (Date applied for under Patents Act, 1901, January 15th, 1903, being date of application in France.) (Complete.)

571. "Improvements in the means of connection between brush-holders and pillars of dynamo-electric machines and electric motors." E. S. G. Rees. January 9th.

574. "Improvements in the construction of the armatures of dynamo-electric machines and electric motors with a view to facilitate the mounting of the same upon their shafts." E. S. G. Rees. January 9th.

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